

Notebook No. 275 - Leverett

COUNTY

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NOTEBOOK 275 - Dr. Leverett

Read pp 61 - 108 in 1932
 " " 1 - 60 in 1943

James Bowen and Mr. Westfall, sec. 35, Ogemaw Twp., have gravel in large amount. See Herbert Bemis in sec. 22 as to gravel there. Gravel near corner secs. 27, 28, 33 & 34, Ogemaw Twp.

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Well Data

Drive with R. A. Smith, Lansing to Leslie, etc. Well on Montgomery farm crest of hill 1/4 mile east of No. Leslie was dug 100' without reaching rock - alt. 1050'±. A well on south side road just east of electric in N. part sec. 16 is 40' to rock and is 70'. One across road at Mr. Locy's is 79' and is only 3' into rock.

Overridden Drift Hills

The large swells north and NE of Leslie in secs. 9, 16, 21 & 22 seem to be drift hills that have been smoothed by a readvance of ice in the way drumlins are thought to have been given their smooth surface. These hills are slightly drumlinoidal. The knolls and ridges of sandy gravel in west part of sec. 11, Leslie, and parts of secs. 10, 14, 15, adjacent to it

are mainly a group of knolls without the esker type of topography. The material is a sandy gravel. It seems to be a water deposit of rather unusual type that has been laid down on the till. It may be only as thick as its relief above bordering till tracts to the SE. We found till on turning south in sec. 14.

Short Eskers and Taint Moraine

We drive east on line of secs. 13 & 24, Leslie, and 18 & 19, Bunker Hill, and then south across secs. 20, 29 & 32, Bunker Hill and sec. 5, Harrietta, then west into sec. 6 and south to Pleasant Lake. There are occasional short esker ridges as indicated in the Rives Jr. Twp. sheet and a topography that is mildly morainic. On the return we came into Leslie from the east and saw some cuts across sharp narrow ridges that run N-S and look like eskers but which have several feet of ordinary till at top, then fine sand a few feet. In some cases there is coarse gravel at base or for 4 - 5' above base.

Gravel for Highways

July 13, 1921. Otsego Lake, Mich. Gravel in the pit 3/4 mile No. of Otsego Lake in SE part sec. 5, Otsego Twp., runs 80% gravel. It is 9' in depth and is opened for about 150' in length. This has furnished gravel for sec. 5 & 4 to the line of Otsego & Bagley twps. As one gets into the hill east of the road considerable sand covers the gravel 8 - 10' or more. In the village of Otsego Lake on land of Mr. White, gravel is found on the hillside slope, over an area of 5 acres or more. He has tested it in several places to depth of 8 or 9' without reaching the bottom. I tested several samples with 1/8" sieve and found the gravel retained in sieve is 55 to 75%. Probably most of it would run 60%. The top to a depth of 3 or 4' is rather earthy.

Sandy Drift Knolls

In north part of sec. 17 a small excavation on east side of road shows gravel that has 70% retained on sieve.

On a hillside slope near center of NE $\frac{1}{4}$ sec. 17 some test pits are opened in which the most gravelly have only 40% retained on sieve. Others show nearly clear sand. Mr. White took me in auto along the road that is to be improved from Otsego Lake to the center of Maple Forest Twp., Crawford Co. We saw no material that has enough gravel with the sand to be of suitable character for use on highways. We ran east into south part sec. 27, Otsego Twp., at the suggestion of the supervisor but found the drift very sandy.

I went east from center of Maple Forest Twp. a mile to an old railroad grade at the side of which is a small gravel pit, in NW corner of sec. 23, Maple Forest Twp. It has only 33% of gravel retained on the screen and there is very little with this amount most of the exposures being sand with only a sprinkling of pebbles.

Gravel Not Suited for Road Material

I returned to center of twp. and went $\frac{1}{2}$ mile, then S. $\frac{1}{2}$ mi. to a gravel pit in S. part SE $\frac{1}{4}$ /NE $\frac{1}{4}$ sec. 20. This has been opened in the top of a small knoll to a depth of 10'. This gravel is rather sandy for road use, the sieve tests showing only 40 to 50% retained on sieve. There is earthy material 2-3' at top. There is only about an acre of this knoll that has gravel exposed and this may be its full extent.

July 19 later tests showed it to be of no value

I went east on line of secs. 21 & 28, Maple Forest Twp. and then S. on line of 27 & 28 without finding exposures of gravel. It was thought by some of the residents that low knolls near middle of line of secs. 27 & 28 might have suitable gravel but it is all too sandy. I was told by a farmer living in NW part of sec. 34, Maple Forest Twp. that he farmed some land

near middle of east side of sec. 34 which has gravelly deposits in a knoll some 20' or more high. He dug into the deposits about 3' and found gravel of good quality to that depth. He says there are several acres of the gravelly surface. I did not have time this evening to go to see this place. I turned toward Frederic at corner secs. 27, 28, 33 & 34 and stopped at the pit in N. part sec. 32. It shows 45% coarse enough to be retained on sieve. This gravel was screened before using on the highway on $W\frac{1}{2}$ of line of secs. 29 & 32 and on line of secs. 30 & 31, Maple Forest Twp.

Some gravel was found on a farm north of this pit about 100 rods from the line of secs. 29 & 32 which is thought to be a little less sandy than at the pit in north part of sec. 32 but it may need to be screened. (See tests later, July 10).

There is a W-S ridge in E. part secs. 28 & 33 and adjacent parts of 27 & 34, Maple Forest Twp. which stands $20\frac{1}{2}'$ in highest part above a high plain to the W. covering much of sec. 28 and N. part of sec. 33. This plain has deep pits in it and there are only cobblestones in the fields so it looks like a high outwash rather than a moraine.

Well Data

There is a high tract along the east side of the MCRR for only 4 miles S. of Frederick. It is about 100' above the low plain that lies between here and Grayling. I learned today that wells on the elevated land north of center of Maple Forest Twp. are 135 to 150' deep and the head is about 125' below the surface. It is thought the drift is nearly all sandy and this depth.

In S. part of Otsego Twp. wells are in some cases 180' on the highest land in secs. 27, 34 & 33.

Sandy Gravel

A cut 4-5' deep along east side of the railway track north of Frederick Station shows sand with only a small percentage of gravel and

cobble - probably less than 20%. This is in a valley that was a line of southward glacial drainage from the high outwash plain near Gaylord. It is a mile or more in width here and seldom is reduced to less than a mile anywhere between here and Otsego Lake.

Crude Mapping

The gravel bar at south end of Otsego Lake is only a few rods wide and seems to have been built up by storm waves or by grinding and shoving of ice cakes in time of rapids??? winds??? from the north. The road does not cross on this bar now but goes around the small body of water to the south. The map by Mich. Highway Dept. is very crude in its outline of Otsego Lake and the roads and railroads are not carefully placed.

Well 220'

July 14. Gravel pit S. of Portage Lake SE of center of sec. 34, T 26 R 4 W, has large pockets of gravel that runs 55 - 75% retained on sieve. It is near the top of a morainic ridge on its south slope. A well here is 220' deep; alt. above lakes?

Small Amount of Road Material

A small pit has been opened about 1/4 mile W. of this that promises well. It is near the top of the morainic ridge. Mr. Houghton, Co. Engr., showed me these pits. In the afternoon I went with 2 men from the road camp 2 mi. S. of Grayling into NW $\frac{1}{4}$ sec. 12, T 25 R 4 W, to a small gravel pit. It has about 4' of gravel that tests 45-60%. Below this is sand with pebbly layers. We dug into it 2 $\frac{1}{2}$ ' or to about 7' from surface. There is about a foot of loamy earthy material over the clear gravel.

We dug 2 pits each a few rods from this open pit and found only 3-4' of gravel suitable for road use. It runs about 45% gravel. Below it is sand with a few pebbles. One test made showed 25% pebbly material.

South of a clearing near middle of N. side of sec. 12 there is a small spot of gravelly land on the slope that rises southward. We dug into it 3-4' in several places and found an earthy gravel.

We examined the hills in sec. 8, T 25 R 3 W as far east as a clearing called the Schutz Farm but found no gravel. The slopes are very sandy with a few pebbles and an occasional boulder. We dug in the clearing 3' deep and found pebbles only in the upper 2'.

Gravel Suitable for Road Material

We went south along the line of the 18-2 highway to the county line. The moraine that leads past the N. side of Higgins Lake has gravelly places that will afford material for highways. The best supply is in the edge of Roscommon Co. in N. part of sec. 4, T 24 R 3 W. There is over an acre of good gravel at top of a morainic knoll. Pits in it extend down 5-6' without reaching the bottom. The gravel tests 70%. It is clear gravel without earthy admixture after getting through about a foot of soil. In places it comes clear to the surface.

Material too Sandy Here

There is a small pit in earthy gravel in the NE part of sec. 5. It is only 5-6' deep and does not have good material for use on the highway 18 - 2. It would not screen well.

On the county line on line of secs. 5 & 32 near middle a small pit has been opened in which there is 50% gravel but we find it runs into yellow sand at depth of 5' and there is only a small area probably an acre that is gravelly.

A Little Good Gravel

There are 2 pits on Mr. Johnson's land in NE part of sec. 4 that have considerable good gravel running 50-70%. They are further from Highway 18 - 2 than the one in N. part of sec. 4 and the gravel is on the whole more sandy. It seems to be a pocket of gravel for a few rods E. of

the western pit we dug into sand on the same level, and where surface is pebbly. The pit in N. part sec. 4 is on the N-S 1/4 line road and the gravel is both sides of the road. Herman Bertel of Roscommon owns some of the land, probably that east of the road.

Good Road Material

July 16. I went with 2 men to the hills NE of Horrigan switch in sec. 28, T 26 R 3 W, and we found thin gravel over the low ridges in $\text{E}\frac{1}{2}$ of $\text{SW}\frac{1}{4}$ sec. 28, usually running into sand at 6' or less. But a very high hill near the center of the $\text{SW}\frac{1}{4}$ sec. 28 has gravel on its N. slope of good quality (50 - 80%) as deep as we excavated at several levels on its slope. Our pits were 6 to 8' deep and all ended in good gray gravel.

Several Kinds of Pebbles Noted

In this gravel we found several "Petoskey stones", a kind of coral that abounds on the beach at Petoskey. Red sandstones are common also that come from W. end of Lake Superior. We also find pebbles of red jasper conglomerate in this vicinity and there is a large boulder of this conglomerate in Mr. Johnson's door yard in NE part sec. 4, T 24 R 3 W.

Good Material

July 18. We continued excavations in sec. 28, T 26 R 3 W and found the gravel for a length $\frac{1}{2}$ E-W of over 50 paces and it is of good quality to the base of the steep part of the hill 50' from level of summit. It seems to be of good quality and of sufficient quantity to cover 5 mi. of road, that is to be done this season south of Grayling.

Material Unsuted for Roads

July 19, 1921. In sec. 29, E. of Frederic. Gravelly knoll - has in first hole 3' rusty gravel, $1\frac{1}{2}$ ' of gray gravel - 45% - $1\frac{1}{2}$ ' gray sand - gray gravel at bottom. Other holes get into sand at 4 or 5' and near base did not get into any gravel at depth of 4', being entirely in yellow sand. There seems to be only a small area in which gravel occurs, perhaps 100'

square in a small knoll and this of uncertain depth. It is 100 rods from the road on the S. line of sec. 29 and would have to have a road built into it. It does not seem to be worth so much expense.

We went to the E. side of sec. 34 and found places that look gravelly at surface have less than a ft. of gravelly coating, below which there is clear sand so it is not fit for road use.

A Very Little Good Material

We examined all along the N-S part of the highway in Maple Forest Twp. without finding any good gravel. It seems likely that the pit in sec. 20 that I examined a few days ago and reexamined today may yield enough for this N-S road in Maple Forest Twp.

We found only one place in the part of this highway SE of Waters that has gravel of good quality. It is at S. side of the highway near top of the hill E. of Waters perhaps 30' below level of uplands. It runs 60%?? 66%??? in the best part. It has 4' of sandy material above the clear gravel and there is a thin bed of gray sand in the gravel. It seems to have a thickness of about 5' of usable gravel, perhaps there is still more deeper down for the gray sand in which we stopped at 9' has some pebbles in it.

Notes from Roscommon to Prudenville

July 20. I went with Mr. M. DeGlopper, Dist. Engr., Alpena, from Grayling to West Branch by auto. We examined the gravel in the hill E. of the Horrigan Switch and at N. side sec. 4, T 24 R 3 W about 3 mi. W. of Roscommon.

We then followed the line of the new highway S. to Houghton Lake at Prudenville. There are hilly morainic areas along or near this highway that are not represented on my map of the surface geology made in 1901. The swamp areas also are very incorrect there being dry land interspersed. Backus Creek has sandy land 12-15' above creek level on each side on this range line and very little swamp N. or for a mi. S. There is a stiff

pebbleless clay in the S. bank of the creek up to 8 or 10' above creek level which is overlaid by a few feet of sand. This does not show in the N. bank.

There is poor land all the way from Backus Creek to Prudenville and for over a mile N. of the creek. From there N. to Roscommon the high land seems fit for farming. It has gravel in sufficient amount to supply material for the highway clear to Backus Creek. In fact it is being hauled a mile S. of the creek and will be continued farther from pit N. of the creek.

We went $1\frac{1}{2}$ mi. S. of Prudenville through sandy plain and there struck an E-W road. We took this E. to West Branch. It was across small stretches of swamp interspersed with the sandy land about as far E. as the head of Backus Creek. To the N. from here in headwaters of Backus Creek are some farms with clay soil in spots - making fair farm land. There is no good land along this road until we enter Ogemaw Co. The moraine extends 2-3 mi. into Roscommon Co. but is very sandy with only a few boulders and gravelly places. But in Ogemaw Co. it is stony and has some clayey till. The farming sec. only extends 4 mi. W. of West Branch.

Notes West Branch to Alger

July 21. West Branch to Alger with Mr. Arthur of West Branch. We went 3 mi. S. in the range line road over strong moraine for $2\frac{1}{2}$ mi. A summit 80 rods S. of the town corners is 1080' Bar. as determined when here some years ago. Some gravel has been found in a small knoll in SW $\frac{1}{4}$ sec. 6, Horton Twp. There is a much better supply in a ridge on the line of secs. 5 & 8, Horton Twp. from which some gravel has already been drawn onto roads. It is only $\frac{3}{4}$ mi. from the line of the highway which is to follow the E. side of the MCRR from West Branch to Sterling and will supply the road as far as Loranger if not farther, perhaps to Greenwood Station on MCRR.

There is undulating till as far S. as Lake George and over much of secs. 17 & 18, Horton Twp. S. of Edwards Lake Spur the land is nearly all sandy. It has considerable pebbly material but not gravel suitable for road use. On the banks of the streams crossed in line of secs. 29 & 30, 29 & 32, 28 & 33, there is a narrow strip somewhat more pebbly than farther back. It is noticeable for 20 rods \pm each side of each of these streams. There is a narrow strip of clay soil crossed by the road in the S $\frac{1}{2}$ of the line of secs. 29 & 30.

The road running east to Greenwood is over a light sand all the way except where the pebbly strips border the streams and these are less definite in streams crossed on line of secs. 27 & 34 than farther W. There is very little swamp land in this sandy area, less than shown on my map. The moraine is entered about 1/8 mi. W. of corners of secs. 25, 26, 35, 36, Horton Twp. It covers only the eastern edge of sec. 35 and the SE part of sec. 25, probably 1/3 of the sec. The divide between Rifle River and streams flowing to the ~~XXX~~ Tittabawassee is only a little E. of the corner of secs. 25, 26, 35, 36 (20 rods \pm).

There are sandy ridges, wind formed, on the highest part of this moraine in secs. 25 & 36, Horton. They are 5-15' or more in height. Mr. A. L. Sheldon, a farmer in sec. 36 and formerly supervisor of Horton Twp., says gravel is very scarce in SE Horton and SW Hills Twps. He knows of none on the moraine and there are only small pockets in the banks of Rifle River barely enough to supply the farmers for building silos, etc.

Well Data

Mr. Sheldon's well is 152' deep and goes 7' into sandstone. There was nearly solid clay for 145'. It seemed to be more stony in the lower part than in the upper 100'. Mr. Brock in E. Part sec. 25 has a well 130' that did not reach rock. The lower part is in rather fine sand.

Some Good Road Material

I went to Alger and there learned of gravel deposits on Wells Creek in sec. 15, Moffit Twp. I find that the gravel as shown by test pits on the creek bottoms runs 45 to 65% gravel. That in the base of the north bluff runs 70 to 80%. There is a fine sand several feet thick over the gravel and above this several feet of clayey till with an occasional boulder. I noted one on the slope 4' in diameter. There appears to be several acres of good gravel in the creek bottoms, the tests having shown it to extend at least 9' deep. This may supply the highway for a considerable distance SE of Alger as there is only a short haul from it to the road that runs S. between secs. 14 & 15, 22 & 23, etc., to the line of the highway in the S. part of Moffit Twp.

Highway Department Map Poor

I find the map by the Highway Dept. does not show the correct position of the MCRR NW from Alger. The RR cuts the NE corner of sec. 6, Moffit Twp. and crosses the line of secs. 8 & 17 80 rods from its E. end. The error is slight at Alger but the map puts Alger in wrong place. It is on line of secs. 16 & 21 from the quarter post W. 80 rods \pm . It lies mostly E. of the MCRR.

Well Data

July 22. Alger, Mich. I went with Mr. Hartwick W. to the crest of the moraine in W. part of line of secs. 18 & 19, Moffit Twp., and found it undulating till with only thin sandy patches. Mr. Hamann lives in NW $\frac{1}{4}$ sec. 15 and he has a well 132' nearly all through clay. The head is -30'. A well 1/2 mi. W. in NE part sec. 24, T 20 R 2 E in edge of Gladwin Co. on ground a little lower is 120' deep.

We returned to Alger and went SE to the headwaters of Bear Creek near corner secs. 25, 26, 35, 36, to find reported gravel but did not strike the right spot. There are a number of roads and no residents to

direct to it.

Little Good Road Material

I went $\frac{1}{2}$ mi. N. of Alger to where Mr. Franklin struck gravel in a shallow well at 3'. I dug to that depth near the well and came into it. It is full of water at that level so it would be hard to handle it even if there is a body of gravel of considerable depth which is doubtful. It is at the edge of a poorly drained swale in W. part of sec. 9.

In the afternoon I continued the exploration along Wells Creek in sec. 15. On the terrace that stands 15' or more above the creek bottoms we dug 11' without reaching good gravel for road use. There are thin streaks of gravel alternating with sand from 3' down to 11' but it is very fine gravel with few stones $\frac{1}{2}$ " in diameter.

Along the base of this terrace we dug several pits and struck gravel that runs 65 - 75% that reaches to a level 4-6' above the creek bottoms. It seems to be as high here as at the pit we dug on the terrace.

We dug a hole in the creek bottoms S. of the creek near where Mr. Kindig had previously dug and found more sand than he found in any holes. We are near a projecting point in the S. bluff so this is on the inner curve of the stream and likely to deposit finer material than on the opposite side. I think, however, that this gravel largely antedates the present drainage lines and has been uncovered by Wells Creek and partly reworked by the creek.

Wells

Mr. Little who lives in the NW $\frac{1}{4}$ sec. 15, Moffit Twp., thinks gravel comes up to within 20' of the level of the uplands where an old well was dug in the east part of the sec. N. of Wells Creek. At the well it was only 7' to gravel but it is in a ravine several feet below the plain. The well at Mr. Little's house is only 24' and gets a good supply of water in sand under till.

Mr. Little outlines the limits of the till area in secs. 11, 12, 13, 14, 15, Moffit Twp. It runs out to within a mile of Rifle River in these sections. The S $\frac{1}{2}$ of Moffit Twp. except secs. 19, 20 and part of sec. 30 (which are till) is very poor sandy land with only a few settlers and there make a living by letting their stock range widely.

Wells in Alger are 85-90' deep and have a head about 35'. They are through clayey till nearly the entire depth.

Gravel of Uncertain Value

There is reported to be considerable gravel on Rifle River east of Alger above mouth of Bear Creek but there is a very steep bluff to get up at the place where the road crosses at the old ford which is probably in sec. 25, Moffit Twp. It is represented to have outcrop in banks 12' high and to be of fair quality. The distance to haul to this highway would be 3 or 4 mi. over a very sandy plain so it would hardly be feasible to use it. Probably it would be necessary to gravel the road from the river to the highway.

July 23. I examined the north bluff of Wells Creek in E. part sec. 15 and found gravel running 45 to 50% exposed for height of 20' or more. It is under a high part of the bluff where a till ridge with E-W trend lies along the N. side of the creek. There seems to be considerable gravel of a grade that will need screening. I went up to West Branch on the 10:42 AM train. There is some pebbly sand in vicinity of Loramer but it does not look to be of high enough gravel percentage to be of use on the roads. There are good supplies in the hills NW of Loramer in secs. 5 & 8, Horton, and perhaps on line of secs. 31 & 32, West Branch. I took the afternoon train to Standish to meet Mr. Deanis of the Highway Dept. and look over the prospects along Rifle River there it cuts through the moraine in SE Moffit and SW Clayton twps.

This moraine is ~~ex~~ capped with sand ridges where crossed by the MCHR in Secs. 2 & 11, Adams Twp. There is another moraine ridge 1-1½ mi. NW of Sterling that has less sand cover so the cuts are a reddish till - Sterling is on a till ridge also.

July 24. I went with Mr. Dennis and the county drainage engineer, Mr. Vogel, to southeastern Moffat Twp. by auto, and then walked across the N. end of the morainic ridge in sec. 36 to Rifle River and followed it up to the mouth of Bear Creek. We found the river bed has good gravel much of the way but there are only patches of gravel in the bluffs a few ft. thick. There is clay to within 20' of the level of the pine plains. This seems to be the case northward to Wells Creek for the settlers only have to drive wells 15-20' to get water. The clay is likely to prevent the water from getting down.

Old Pit Exhausted

In the afternoon I went by auto from Standish to West Branch via Sterling, Maple Ridge and Prescott. We crossed Rifle River in sec. 5, Deep River Twp. and passed a gravel pit near the center of sec. 5 in north bluff of Rifle River. Mr. Dennis says this is nearly exhausted. It was thrown open for several miles of road on the highway from Sterling to Maple Ridge.

The moraine which traverses Clayton Twp. from SW to NE is strongly undulating and has very little sandy capping. It is a good farming section. This and the bordering till plains make a strip about 4 miles wide of good land. The SE corner of Clayton Twp. is on sandy plains - and 5 or 6 sq. miles in NW part near Rifle River are also sandy. I went through good farming district much of the way from Clayton Twp. around to West Branch.

There is gently undulating till north from Prescott to Styles Lake. We turned west at corner secs. 21, 22, 27 & 28, Logan Twp., Ogemaw Co. and kept west till we crossed Rifle River. The surface is morainic nearly all the way. The river here has a narrow valley cut in till. There

is some gravel on the till and a shallow gravel pit 6 - 8' deep on west side of the river in SW part of sec. 21, Churchill Twp.

We went north $2\frac{1}{2}$ miles over strongly undulating till then west to Campbells Corners and then SW into West Branch. The surface is strongly undulating till but is not so sharply morainic as the country 2 - 4 mi. north of the road that runs from Campbells Corners to West Branch. It is like the Maple Ridge country. I have classed that as morainic but in my early studies I classed the undulating land NE of West Branch as ground moraine.

July 25 - I went from West Branch along the RR track $1\frac{1}{4}$ mi. then south between secs. 31 & 32 over a prominent ridge that has considerable gravel at top but a till nucleus. It seems a favorable place to get gravel for the highway, though there is considerable oversize material. A sharp esker-like ridge runs about 40 rods SE-NW on the top of this hill mainly in sec. 32. It is 15' or more high and only a few rods wide. Its slopes are cobbly and Mr. Cook who owns the land says the RR company tested it and found gravel. It seems important to determine whether it is the right grade for use on the highway as it is very convenient for supplying the first 3 mi. SE from West Branch.

Some Fair Road Material

I went to the pits in north part NW $\frac{1}{4}$ sec. 8, Horton Twp. and found that much of the gravel runs 70 - 80%. There are sand pockets. There are also places where boulders and cobble are numerous - especially in test pits SW of the main pit. There is gravel in a pit on north side the road about 60 rods from E. end of road about 60 rods from E. end of line that runs 65%.

There is likely to be considerable gravel in the SW $\frac{1}{4}$ sec. 5 in the shaly ridges. Some test pits in the NW $\frac{1}{4}$ /SW $\frac{1}{4}$ Sec. 5 show a rather sandy gravel but it might pay to screen it. It is only 1/4 mi. from the RR.

July 26, Roscommon, Mich. I was taken by auto to Keno and went from there to a ridge in secs. 26 & 27, T 24 R 1 W in which there is gravel in pockets and thin beds. A pit on east side of road has been opened 6-7' deep. Its walls are more than half sandy material. The pockets of gravel test 60% where best and from there down to 25%.

There is a test pit west of the road a few rods opened 6' deep that is gravelly to bottom and tests 50%. I dug into a ridge in an open field west of the road to depth of 3' in gravel that tests 45% and did not reach the base.

Material of Doubtful Value

But both No. and W. of this place there is sand under about a foot of pebbly material. There probably is only a narrow and short strip of this gravel, perhaps 20 rods long and 4-6 rods wide. I found places along the So. edge of the high land in which there is gravel at surface on some of the highest points.

I went back later and dug through the gravel into sand at 3 $\frac{1}{2}$ - 4'. This is on the slope 3' lower than crest of ridge. I dug on the crest and found sand at 2 $\frac{1}{2}$ - 3' and a less pebbly deposit above the sand than in the pit in the slope. So it now seems that this ridge will not yield gravel of any value. I went E. along the ridge about 1/2 mi. to a high point that is somewhat bouldery and dug a pit about 2' that is clear gravel but cemented so that it will require a pick to excavate deeper.

I arranged with a farmer living near to dig it and report to Mr. Blanchard, Co. Commissioner at Roscommon. This farmer says there is good gravel under the road on line of secs. 26 & 27 that was reached when grading. This is opposite the test pit noted above on W. side of road. Just No. of here the road is in a red clayey till for a few years. This clayey till comes in on the slope between the first gravel pit noted above and the test pit. The postmaster at Keno says the red till on the plain around Keno is seldom more than 4' thick and is underlaid by quicksand. It seems to blanket a somewhat uneven surface and is present in swales as well as on the general level.

Wells

There are a few surface boulders on it and it contains a few pebbles. The wells are generally shallow, that at the post office being 14' and one at Mr. Shiels??? Shield??? in NW part sec. 26 only 10'. Mr. Shiels??? Shield??? well has a large manure pit within 10' of the pump and on the uphill side so it may easily contaminate the water.

There doesn't seem to be a gravel deposit under this blanket of till near Keno. The plain south of the ridge in secs. 26 & 27 has sand with very few pebbles so is not likely to yield gravel for the highway.

On my return an auto took me No. from Keno to middle of line secs. 15 & 14, then E. $\frac{3}{4}$ mi. and No. to railway grade that runs NW in secs. 11 & 10 to an E - W highway a mile So. of the county line. In this, coarse clay was found only to a stream running NW across sec. 14. There is sandy land along this stream and the RR grade.

Morainic topography sets in near the place marked "Herbert" in the Highway Map and extends west on the line of secs. 4 & 9 into secs. 5 & 8 and there is undulating bouldery land of loose texture to the twp. corners on the co. line. From there W. to Roscommon there are jack pine plains with gentle undulations and an occasional surface boulder.

Well 90' Small Amounts of Good Material

July 27. I went with the highway engineer, Mr. Copeman, to the bridge on a branch of Au Sable River at corner secs. 8, 9, 16 & 17, T 24 R 1 W. South of here $\frac{3}{4}$ mi. on land of Dr. Schumacher there is a hill in which I got gravel testing 40% to depth of 4'. It is about 15 rods SE of his shanty and about 6 rds. from the highway. There is a gravelly strip from here SSW beyond his clearing for 30 rds. or more that may be of value. There ought to be several test pits 6' deep made on it. About 80 rds. south of the Schumacher clearing is John Brant's place. He has tested for gravel on the crest of the hill near his house but found it in thin beds with beds of sand between in pits about 6' deep. His well is 90' deep and has only 10' of water. The hill on which it is located is 50 - 60' above Au Sable River.

I found a small outcrop of gravel in W. part of sec. 21 on So. side of road that tested 40% in a pit 3' deep dug in the road ditch which is 2 - 3' below the ~~natural~~ natural surface. This is gray gravel. I tested some gravelly spots in the field south of here but got into sand at $1\frac{1}{2}$ - 2'.

I went next to a pit in sec. 25, T 24 R 2 W in east part of SE $\frac{1}{4}$ from which considerable gravel has been taken for roads, the pit being about 50 x 40' and 4 - 6' deep. I was unable to find anything here that tests over 35% and in several places only 20%. It is yellow sandy material. I dug 3 - 4' in deepest part of the excavation and found it a slightly pebbly sand hardly as good as that in the banks of the pit. This pit is not worth considering for Highway 76 for it is $2\frac{1}{2}$ mi. from it and material too sandy.

Very Little Good Road Material

I interviewed Mr. McCrea who lives in No. part of sec. 31, T 24, R 1 W and he says he has seen very few signs of gravel in the hills in

secs. 19 & 30 or anywhere between here and Highway 76. He has been here 40 yrs. and is an observant man. I noticed pebbles of red jasper conglomerate in secs. 17 & 20 that show movement from north of Georgian Bay. There is a moraine from the SW part of sec. 16 SW to the MCRR No. of Geels Sta. There are sandy jack pine barriers W. of the range. E. of it there is some jack pine in sec. 29 and E. part of sec. 30 on level land but clayey till appears to be near surface so that road ditches strike it.

I am unable to make a clear interpretation as to the direction of ice movement that formed this range of hills in the SW part of T 24 R 1 W. My mapping of the morainic hills is far from complete in Roscommon Co. and should be given further attention if possible while in this highway work.

Hoagland Pit Fair

July 28. W. Hoagland's pit in sec. 29 ($SE\frac{1}{4}$) T 25 R 1 W. Tests at W. end 70 - 80%. Tests at No. side near E. end 80%. Test at So. side near E. end 50%. Sandy and earthy cover 3 - 5'. Very little oversize. Much fine gravel $1/2''$ or less. Matrix gray sand below the sandy earthy cover. Pit has been opened 5-6' in gray gravel in deepest part.

O. F. Barnes of Lansing owns Land at Pit

I tested in the road in So. part sec. 29 and found gravel with only 3-6' of sandy cover at several places. My pits were in road ditches starting 3-4' from level of ground. This gray gravel is rather sandy and may not run over 40%. It was too damp to run through the sieve. I am told by Mrs. Hoagland that Mr. Charles Blanchard of Roscommon has tested between the pit and the road and found gravel at slight depth. I dug a hole 4' but did not get into it. It was through yellow sand. Hoagland's address is Roscommon. He has received 25¢ per yd. for some of the gravel used on the bridge on Au Sable at corner secs. 16, 17, 8 & 9, T 24 R 1 W.

I went from Hoagland's E. to line of secs. 27 & 28, T 25 R 1 W, then S. up a steep hill with gravelly slope about to the corner of secs. 27, 28, 33 & 34 where there is a small gravel pit at W. side of the road. This has 3-4' of loamy gravelly material below which is fresh gray gravel, the best of which tests 75-80%. There is but a small amount of oversize pebbles. The gravel is medium to coarse so far as exposed with less fine gravel than in the Hoagland pit. The excavation is about 25 x 40' and 5' deep in deepest part.

I continued S. a mile beyond the Co. line through a narrow plain just No. of the Co. line and over morainic knolls on line of secs. 3 & 4, T 24 R 1 W. These are a more sandy drift than the higher range in Crawford Co. about a mi. N. of the county line. I dug into the crest of ridge near W. end of line of secs. 4 & 9, T 24 R 1 W to a depth of 3 $\frac{1}{2}$ -4' and found sand with but few pebbles.

Large Pit in Good Gravel

July 29, Roscommon, Mich. I went with Charles Blanchard to the large gravel pit in T 25 R 2 W, sec. 27. It is on a nearly plane tract So. of a branch of the Sable River. Fully 40 acres of gravel 6-12' thick have been removed and he estimates the amount to be not less than a million cubic ~~yds.~~ yds. About 400,000 yds. were taken out by the MCRR before he took the pit. There is good gravel to the W. of this excavation for 40-60 rods, but farther W. there is deep sand. The sand cover where the pit is now being worked is from 2' or less up to 8 or 10' as it fills depressions in the gravel surface. There are places where the material is very coarse with cobblestones 6 - 8" in diameter making a considerable percentage. These are culled out and make large heaps in the bed of the pit. But most of the gravel is of good grade for use. There is some loam in the upper part in places and this is used as it makes a good binder for the roads. Most of the material is a gray gravel with fine sand matrix.

I went at noon to St. Helens but was prevented by rain from getting out to look for gravel. I am told there is gravelly land west of the west end of Lake St. Helens in sec. 24, T 23 R 2 W on the east side of a range of hills that lies mainly in secs. 23 & 26. There is also a gravel pit in the NW part of sec. 32, T 23 R 1 W on north slope of a range of hills that runs through secs. 31, 32 & 33. These hills generally are sandy. South of them is a till plain of several square miles as indicated on my county map. There are strong flowing wells on the Whitaker ranch at the west end of Lake St. Helens, flowing a stream the full size of the pipe, 3 inch?

Gravel Near Beaver Lake

From St. Helen north there is considerable wet land but not so much as is indicated on my map there being dry sandy plains interspersed with wet strips. The hills east of Beaver Lake Station I am told are gravelly. They are within a mile or two of MCHRR. One has a Forestry Fire Observation Tower on it.

July 30, 1921. St. Helen, Mich. I went with Mr. Becker to examine gravel prospects south from St. Helen. We drove across a sandy plain $2\frac{1}{2}$ miles. We then turned west on the line of twps. 22 & 23, R 1 W and rose to a higher tract with nearly plane surface and considerable gravel on the road where it crosses the small ravines that lead north into lower land. We excavated some of these gravelly places but found there is too much sand to make a good material for road use. It runs 20 to 30% gravel and is a rusty loamy material. This high land occupies a considerable part of sec. 3 and south edge of sec. 34. It is 30-40'± above the land around it.

We drove south on an old winding road near line of secs. 3 & 4, 9 & 10, T 22 R 1 W, and then went to a group of prominent knolls on the Schwartz farm near the center of sec. 16. Two small gravel pits have been

opened in these hills, midway of the slope and near the top. In places the gravel is thin and sand sets in it 5-6' or less. In one place we dug to a level 6 or 7' below natural surface and were in good gray gravel the lower 2' that runs 60%. Most of the gravel exposed runs about 40%. The two pits have each had a dozen or more loads hauled out. They are high up on the slope of a prominent range of hills 75' or more above the level land in NW part of sec. 16. These hills seem likely to have a coating of gravel of considerable extent. We did not take time to dig outside these pits as we wished to examine hills closer to the highway.

Quality of Material not Promising

We went to a very sharp hill east of the highway near north line of NW $\frac{1}{4}$ sec. 14 and found its highest part is gravelly. We dug several pits 3' and one 5' deep without getting into sand. The gravel, however, has a low percentage 50 to 40% and we did not get through the rusty?? part. The ~~matrix~~ matrix is fine pebbles rather than sand but they go through an 1/8" sieve. Mr. Becker thinks this fine material will make a good binder in the top course. In general this gravel is fine but Mr. Becker dug one hole that struck cobbles and he was not able to dig it with a shovel so only went about 15 inches deep. I examined the winding crest of this knoll for 25-30 rods and found it gravelly, and there is gravel down the slopes for 15-20' or more below the crest. It, therefore, seems a favorable place for making test pits.

There are other sharp hills to the south near the line of the highway that Mr. Becker thinks are gravelly. The road runs around the base of one such hill and cuts into gravelly material. We had not time this forenoon to explore farther so returned to St. Helen and I took the noon train back to Roscommon and spent afternoon and part of Sunday, July 31, in making out report for the work of the month and preparing expense accounts to send to Lansing.

Small Gravel Pits Between Houghton & Higgins Lakes

August 1, 1921. I drove from Roscommon past S. end of Higgins Lake and Markey Twp. I passed through scarcely any swamp in secs. 13, 14, 22, 23, 24, 27 & 34, T 24 R 3 W, there being dry sandy land nearly all level. South from Markey there is dry stony, sandy loam in secs. 4, 9, & 16. Small boulders in places being very numerous. There is a gravel pit near line of secs. 15 & 16 west of the outlet of Higgins Lake on level ground. There are also small pits in the moraine in sec. 4, Markey Twp. There is considerable swamp in sec. 21, Markey and small swamps E. of Houghton Lake.

Some Good Material Near Prudenville

From ~~Exa~~ Prudenville I went SW to Mr. Knight's in SE part sec. 30, T 22 R 3 W, and found some test pits for gravel of good grade to use without screening. At Mr. Knight's house the well is in gravel 36'. There seems to be several acres of the gravel N. and W. of his house. It tests 75-85%. This is 3 mi. from the trunk line road and a good road to haul over, so Mr. Knight states. He considers his gravel N. 20 cents a cubic yd. This is at top of a morainic ridge that rises about 40' above the lowland S. of it.

Some Gravel

I went next to James White's in NW part of sec. 30 where gravel of good quality covers several acres and has been tested to depth of 12' in one place and 6-8' in several others. There are several acres of good gravel here. There is also gravel west of this at his house. The well there is in gravel 40'. It was sunk to 87' but has 45' of water.

Mr. Butler in SW $\frac{1}{2}$ sec. 19 has a well 147' deep on a ridge. It had only 2' of gravel. The water supply was weak at 115' so well was deepened. In S. part SW $\frac{1}{2}$ sec. ~~19~~ 19, across the road from James White's is an open gravel pit from which gravel was hauled last winter past

Prudenville and stacked along the line of the Highway No. 18. There is one place where it gets into sand at 9-10'. I dug here 3' in sand without reaching the bottom, but elsewhere in the pit gravel extends to greater depth. This pit and 3 acres of land with it has been bought by Mr. McKibben of Prudenville.

I noticed a peculiar sandstone in the drift here mainly of gray color but with red bands. One in Mr. White's yard has an impression like a deer's foot where some concretionary part has weathered out. There is a show of gravel in ditches at the roadside north of middle of line of secs. 19 & 24, T 22 Rs 3 & 4 W, but no pit has been opened.

On the line of secs. 13 & 24 W. of middle on a W. facing slope is a gravel pit opened to depth of 3', length of 100', and width of 60-70' that has a loamy matrix. The gravel varies greatly in its percentage, some being as high as 60-70 while most of it is 50 or less. At the W. end and lower part of the slope a pit in bottom of large pit has been dug 2' into gray sand with few pebbles. Test pits around this open pit show loamy matrix to gravel as deep as they go 4'±. There appears to be several acres of this sort of gravel. There is a board on tree here marked E. E. Ballou, Prop.

There is a gravelly material at S. edge of high ridge N. of corner of secs. 13, 14, 23 & 24, about 60 rods excavated 3-4' in a gravel with loamy matrix.

Old Pits Show Near Houghton Lake

About 1/4 mi. S. of Houghton Lake village on W. side of road in sec. 14 is a pit 15' deep. It has earthy or loamy gravel for ~~matrix~~ 3-5' below which is gray gravel running about 60%. It is rather fine gravel. The earthy cover has more coarse material and a few boulders among which I noted a red jasper conglomerate. There is sand in the deepest part of the pit but it appears to be in thin layers and small pockets. This seems

to be good material for highway use without screening. I find the sandy gravel in bottom of pit on north side tests 40%. This pit is about 80' across both N-S and E-W. It is in a sharp knoll that embraces only about 2 acres and this may not all be gravelly.

Red YS

I find a red sandstone with greenish or bluish spots of the kind found on south side of Lake Superior near east end and such as I found specimens of in SW Michigan and referred there to the L. Michigan ice lobe. I am told a pit in NE part sec. 15 has 8-10' of yellow loamy gravel below which is yellow sand in places and in places clay.

A pit on line secs. 3 & 10 T 22 R 4 W has only 5-6' of gravel over sand. There is a gravelly hill on line secs. 4 & 5 near middle in Wellsville??? which a small pit has been opened. This is 1/2 mile south of Wellsville. Another pit has been opened on a gravel ridge in north part sec. 30 T 23 R 4 W about a mile SS^W from Michelson.

Data given by Mr. Ogden. On the road from Houghton Lake village to Prudenville the only ridges crossed are near line of secs. 17 & 20 T 22 R 3 W and these are very sandy. The road elsewhere is on a sandy plain.

Gravel in Forest Reserve.

August 2, 1921, Prudenville, Mich. I went with A. F. Detmer south along Trunk Line 18 to explore for gravel. This leads through a sandy plain for some miles. We find a gravel ridge in the Forest Reserve west of center??? sec. 12 T 21, R 3 W that tests good gravel to 15' depth by 3 test holes - one on top and two on sides that run 60% to 80%. It is fine gravel with scarcely any oversize.

There is no stripping needed. The matrix is sandy from near top. There is a gravelly top and slopes for a length of 130 paces or 390'. The ridge is 15-25' high and very sharp on both slopes like an esker.

It is perhaps 150-175' wide at base. Its area squared up will be

$$\begin{array}{r}
 \text{about } 80 \times 20 \times 390' = \\
 \hline
 1600 \\
 234000 \\
 \hline
 390 \\
 27)624000 (2300 \text{ cu.yds.} \\
 \hline
 54 \\
 \hline
 8400
 \end{array}$$

We find, however, that the east slope has deep sand so there is likely to be not over 1500 cu.yds. The higher hills west and NW of this ridge prove to be sandy with only a thin pebble veneer.

Good Gravel Near Meredith

We went to a pit N. of Meredith 1/2 mile on the county line which has good gray gravel testing 75% as deep as we dug in bottom of pit or fully 10' from surface. The gray gravel has about 3' of loamy and sandy pebbly material over it. This does not seem to have much extent for higher land to the SW is sandy to depth of 4' a loose yellow sand. On the county line a few rods south there is a clay deposit 2' beneath which is sand. This gravel has but little oversize material and looks to be of good quality for use on highways. It is doubtful, however, if more than a fraction of a mile can be supplied from it. Its extent to the east and north remains to be determined. I interviewed a man who is keeping this part of the road in NE Clare County in order and he says he has found indications of gravel NW from this pit as well as No. and E. He thinks there is enough gravel there to supply the highway from Meredith to the county line of Roscommon County. From Meredith to Gladwin there will be no difficulty in finding enough for the Highway 18.

Gravel Between Gladwin and Meredith

We found a small pit on E. side of the road in So. part of sec. 1 T 20 R 3 W but the gravel is only 3-4' thick and is underlaid by yellow sand. We are told by Mr. Nash, one of the Gladwin Co. Commissioners, that there are good indications of gravel in the SE part of the SE section of the Forest Reserve (sec. 36 T 21 R 3 W).

Gravel in Ridges

August 3. Mr. Detmer took me to a prominent range of hills in sec. 18 (SE $\frac{1}{4}$) T 21. The road between sec. 18 & 13 crosses gravelly points about 1/4 mile from So. end of the sec. line in which we dig several test pits 4' deep that are in gravel to bottom. The best tests 80% and the sandy tests 45%. This is exposed for 20 rods[±] along the road. It seems to go under a sandy cover each side of the road - the road being across a very steep slope. These gravelly points are not on the highest part of this range. It rises 50' or more higher in the SW $\frac{1}{4}$ /SW $\frac{1}{4}$ sec. 18. This high part is very sandy.

We went to a surveyor's camp by a swell[?] in sec. 30 for dinner. There I met Mr. McKibbin of Prudenville who says he has found gravel on a hill east of center of sec. 12 T 21 R 3 W that is good as that we found yesterday W. of the center of the section. He tested that ridge also. He only put down single test holes about 4' deep in each place. He is part owner of the pit in SW $\frac{1}{4}$ sec. 19 T 22 R 3 W visited Aug. 1.

We went So. along the range line and E. edge of the Forest Preserve and find a few gravelly places in the road and fire line but the greater part of the road shows sandy material in the slopes. At corner secs. 30 & 31, 25 & 36 T 21 RS 2 & 3 W, we made a test pit 6' deep mainly in a gray pebbly sand of good quality for plasterer's sand. The pebbles only make 30% or less of the deposit. Other pits E. & W. of this a few rods do not enter a gray sand but are in yellow sand. This is on a prominent ridge.

Near the middle of the line of secs. 31 & 36 is a prominent ridge that we tested with several holes about 4' deep. In only two cases were they in sand, the others being in gravel that tests from 30 to 65% much of it being about 40%. There is likely to be a deposit of enough material to gravel a mile or so of road if it was all 65% material. But

most of it is lower grade. A ridge near center of SE $\frac{1}{4}$ sec. 36 has pebbly material on its crest and slopes. This is one of the highest points in this vicinity. A spur from it runs SSW across the county line and this has a pebbly sand at surface.

Gravel in Ridges

We tested a very sharp hill south of the camp in sec. 30 just after dinner but found it sandy with a very thin coating of pebbly material in places on its summit. It now appears doubtful if enough material will be found along?? the E. side of the Forest Preserve to gravel the road across it. Mr. Detmer found gravel on a ridge near E. end of line secs. 12 & 13 in the east part of the Forest Preserve. He dug 3 holes 3 $\frac{1}{2}$ -4' deep without getting through it. It becomes a gray color near bottom of test holes. Mr. McKibbin says there is a little gravel on a ridge near the 1/4 post of sec. 12 and sec. 7, T 21 Rs 3 & 2 W at east edge of Forest Preserve.

Pits in Forest Preserve

John Callihan of Chicago owns land N. of T. H. Knight's in sec. 30 T 22 R 3 W in which gravel tests have been made. One of these ends in gravel testing 80% at depth of 6'. Loam at top for 1 $\frac{1}{2}$ '. We dug a pit in Mr. Knight's garden a few rods east of road and found clear gravel at 2' testing over 90%. There is 1 $\frac{1}{2}$ ' of yellow pebbly sand at top, and then a crust of brown gravel below which the clear gravel sets in.

We dug in the road at a place that looks very cobbly about 40 rods N. of Knight's house and went into yellow sand at 3'. We dug to 6' without reaching the bottom of this sand. Mr. Knight says his house has clay under the E. end to depth of the cellar but the W. end is in gravel. This is the E. edge of a gravel area that he thinks covers 3 acres or more on his NE corner and Callihan's SE corner.

The overseer of the Forest Preserve, Mr. Van Sickle, came along while we were at Knight's and told us of small pits of gravel in No. part of secs. 3 & 4 T 21 R 3 W in the Forest Preserve. We examined one pit from which a gray gravel good for use in cement was obtained. There is only a small pocket of it about 4' thick, with sand underneath. We dug 2 or 3' into this sand without getting through it. This pit is on the slope of a basin in a plain south of the moraine. There are basins with slightly pebbly rims for a mile or more further E. or about to line of sec. 2 and sec. 35 on the Forest boundary.

We went to the high moraine in sec. 34 but found it sandy. Mr. Knight says there is very little gravel in it E. from sec. 30 so far as he can find. There is an old gravel pit in NE part sec. 32 he says, but it is not likely to furnish much more gravel.

Hills in Forest Preserve

Mr. Van Sickle indicated the location of hills in the Forest Preserve that I had not located when here in 1901. There is a short range S. of the headquarters in secs. 7 & 8 T 21 R 3 W over 50' high. A hill near center sec. 17 is 30' or more above the plain. There is hilly land in sec. 8 as well as secs. 17 & 18 of T 21 R 3 W. He says there is a topographic map of T 21 R 3 W showing the general character of that twp. He has a copy at headquarters.

I returned to Prudenville for dinner and took the mail stage back to Roscommon. This goes the direct course mainly on the range line of ranges 2 & 3 W. The hilly tract that I overlooked in early mapping is near the town corners 6 miles from the No. line of Roscommon County, more largely in secs. 31 & 36 than in 1 & 6. Between this hilly tract and the swamp south of it is a narrow shady plain 1/3 - 1/2 mile wide. The swamp on this range line is fully 1/2 mi. wide. I took afternoon train to West Branch.

Gravel Near West Branch

August 5. I went W. from West Branch 4 miles and then No. a mile to Boutell's ranch. Gravel was reported to occur here in secs. 16 & 17, Ogemaw Twp. I found it in small pockets in SE part of sec. 17 & SW of sec. 16. A pit about 80 rods NW of sec. 16. A pit about 80 rods NW of the ranch buildings in a low gravelly knoll enters gray gravel at 2-2½' that tests 60%. We dug in it 1½' without reaching the bottom. But about 60' E. from this where the slope is still pebbly a pit enters yellow sand and is in it as deep as we dug 4'. At a similar distance W. cobblestones were so thick that we only dug 1½'. A ridge 40 rods No. of this one is sandy so that crops are very poor. One a similar distance So. has red clayey till on its crest. The land is thus very spotted and irregular in its make-up.

On the SE part of sec. 16 at a RR grade No. of the residence of a Polish farmer a small gravel knoll is cut through in which a test pit at side of the grade went 9' through good gravel without reaching the bottom. I tested the exposed part about 2' from top and found it 75%. We put down 3 test pits a few rods from this to the No. and NW on a gravelly part of the small knoll and found yellow sand in two of them at a few inches depth. The other was too full of cobblestones to dig easily so only went 1½'.

Poor Prospects in W. Part of Ogemaw County

In both these places in secs. 17 & 16 the good gravel seems to be in small pockets only a few yds. in diameter. A sharp knoll in sec. 16 on So. line of a Forest Reserve curve??? or cross??? by its fire line has a yellow pebbly sand running about 50% pebbles. We dug two pits in it about 2' deep and saw no change to better. The Polish farmer says his fence posts on this hill are in this pebbly material to bottom 2½-3' on the slopes and crest of this hill.

About 120 rods E. from here the fire line of the Forest Reserve crosses a sharp ridge 60-75' above a stream west of it and this ridge has a few feet of pebbly material on its crest. The slopes are sandy except near the top. It is doubtful if this contains enough gravel to be of value for the highway.

The sons of this Polish farmer Klayski in sec. 16, say that tests were made 2 years ago in the knolls from here W. to the line of Roscommon and Ogemaw Counties for a mile or more No. and So. of the proposed highway on line of secs. 17 & 20, 18 & 19 West Branch Twp. but all the pits were in sand. The testing was done by a Saginaw man (name not remembered). It seems doubtful, therefore, if local gravel of any value is to be found near the proposed trunk line road 76 (project 9B) in the Ogemaw part.

There is said to be gravel in hills near corner of secs. 27, 28, 33 & 34, Ogemaw Twp. There is a large amount in W. part sec. 35 which will probably be used in the construction of its road running W. from West Branch.

Some Good Gravel in SW part of West Branch Township

Aug. 6, 1921, West Branch, Michigan. I went to a gravel ridge in SW $\frac{1}{4}$ sec. 32, West Branch Twp. and made several test holes on land of David Sharp with assistance of Norman Bragg and son, Clarence. The ridge is a very sharp one that is perched on the slope of a high hill. It trends NW-SE for 50-60 rods from the place where the sec. line road crosses the hill and drops its altitude at SE end is perhaps 30' less than at the road yet it maintains a relief of 15-20' above the part of the hillside slope each side. Its west side is regular but its E. side has projections of a few rods. We began at So. end and found sand in a test pit on crest and also on slope. We then went about 10 rods farther No. and found a good grade of gravel. A pit on the crest tested 60% at

depth of 7' and will average above 60% from top to bottom. A pit on west slope opposite the last one tested 85% at 2½' and also at 5'. It is fine gravel with very few coarse stones. On the E. slope opposite this a pit 7' deep shows 70% gravel test at bottom and of fine quality for top course. It is of good quality from top to bottom. A pit farther down on E. slope went through a bed of sand at 3-5' from surface below which is a fine gravel which was dug into 2½'. It tests 70% and is good for top course.

We then went farther No. and put a test pit on crest 6' that was above 60% to near bottom when it tested 60. This has no sand beds or streaks and but is not so uniform than the others some coarse stones being present. Two pits east of this on E. slope a few rods apart each showed good gravel from top to bottom and were put down 5'. They tested 75 to 80%. These two pits are on a spur that extends E. a few rods. Between this spur and another S. of it in the depression - a pit 5' deep was in loamy and sandy material 4' and got into gravel at 5'. This loam is probably a wash from the slopes.

Supply for West Branch Township Roads

We made a shallow test on the high part only a few rods from the sec. line road and found poor showing to depth of 3'. A stony loam at top 1½-2' and then a light sand.

The road cut shows the structure of the highest part of the hill to a depth of 25'. In the deepest part there is red till at base over which a veneer of cobble & gravel about 12' thick is spread. On the No. slope on E. side of road there is considerable gravel of good quality for road use. Enough gravel was taken out of this hill in the road to gravel the road for a mile on line secs. 31 & 32 to width of 9-10'.

There seems to be at least an acre of good gravel on David Sharp's land with no stripping necessary. It may run 12 to 20' deep and be sufficient to gravel F.A.55 from West Branch to the So. line of the twp. nearly 3 miles. This will be a more convenient source than from the hills on line of secs. 5 & 8 Horton Twp. for the part of the road in West Branch Twp.

Gravel for West Branch Streets Found Nearby

Sunday Aug. 7. I went to a gravel pit just E. of the village limits of West Branch in SW $\frac{1}{4}$ sec. 20 that has been in use for many years and from which material for several streets in West Branch was obtained. It has considerable good gravel 60-70% in pockets or narrow strips. There is also some good material for plasterer's sand a sharp sand of gray color with small pebbles scattered through it. The borders of the excavations of which there are two have sand several feet thick above the gravel that is of a yellow color and not fit for use - the expense of stripping this may not be heavy as it is in a clear pasture field and can be handled rapidly with scrappers.

Gravel Shipped in for Highway

There are places where the gravel has a loamy matrix so it is not considered suitable for concrete road. There are other places in the pit, however, where it would be suitable. There has been $1\frac{1}{4}$ miles of cement road laid this year in West Branch and material for the concrete was shipped in as the State Engineer thought this pit (noted above) ran too much to clay matrix to be safe to use.

I am told there is gravel 2 miles No. of W. Branch between the range line road and one a mile E. But this is not near enough to be of use in F.A.53. The one in sec. 20 might be drawn upon if necessary. The owner of this pit, Mr. Gillis, is charging 50¢ a yd. for the sand suitable for plasterer's use. He thinks it will serve the local need for all sorts of mason and concrete work for sometime to come.

Gravel in NW Part of West Branch Twp.

There is reported to be a gravel pit on the No. line of West Branch Twp. about $3/4$ mile E. of the NW corner of the twp. on a prominent ridge in the Forest Reserve. There is some gravel on the Poor Farm (Co. Infirmary) in sec. 20 No. of Mr. Gillis. But it is thought to be of small amount. I did not go out to see it.

Assisted in Excavating by John Beach & W. L. Bundy

Aug. 8, 1921, West Branch, Mich. George Crisher in SE corner of sec. 28 has 2 acres \pm of gravel that runs in places 75% and most of it 60% or more. The sandier part is 45%. Some steep hills to get out north near line of Roscommon and Ogemaw; the prominent hills have pockets or strips of gravel but pits in them more often go into sand. Nothing of value for contractors. About a mile W. of the county line a sharp ridge So. of the road shows gravel at top and a few feet on slope but the pit on the slope went into sand at 4-5'. Other pits on the crest went at once into sand. We tested a sharp ridge No. of the road also about a mile W. of the County line and found places in which gravel tested 70% but other places a few rods away are sand from top to bottom of test holes 4' deep. So neither of these places nor one in SW corner of Bontell's ranch (sec. 18, Ogemaw Twp.) have enough to pay a contractor to engage for highway use.

We went to sharp hills that are probably in $W\frac{1}{2}$ of sec. 14 T 22 R 1 W So. of the road and about 60 rods SW of springs that issue on No. side of road. We made one test hole and found fine gravel as far as we tested 3-4' that runs about 45%. Mr. Becker, the maintenance man on this part of Trunk Line 76, will dig other holes here and in neighboring sharp hills to the So. & W. We found the lower part of the slope of this hill sandy so are skeptical of there being much gravel here. This hill is about $1/2$ mile from the one on north line of sec. 14

that Mr. Becker and I tested a few days ago and found to have gravel near the top. The hills on the Swartz farm in sec. 16 have gravel in pockets rather thin in a definite strip. So I am rather doubtful of there being much in those hills. They should be given further tests before any contractor can be sure of the value.

Tests in Ogemaw Township

We went W. on line of secs. 20 & 29, Ogemaw Twp. and made two test pits on ridges crossed by the road. In one a stony loam was found as deep as we dug $3\frac{1}{2}$ '. In the other a stony sand. We went to James Bowne's gravel pit near center sec. 35, Ogemaw Twp. The gravel here is of good quality over an area of 4 acres on a ridge that stands about 15' above lower land to the W. In one place at the pit it has been excavated 22' in good gravel. There seems likely to be an average depth of 15' over the 4 acres. Ridges E. & S. of this one of similar height are more sandy. The gravel at the pit is mainly free from oversize stones. Some of it will make good top course material for highways, and some that is coarser will make the base course. The sieve tests I made show 70 to 75% gravel. The haul from here is over a good road with small hills along it to the highway running W. from W. Branch, a distance of nearly 2 miles.

Gravel in NW Part of Horton Township

I went with W. A. Grandall, one of the Co. Commissioners, to the gravel pits in sec. 5, Horton. There on the ridge So. of the large excavation, in test pits, show gravel 70 to 85% after getting down 3-4' through a more cobbly deposit with sandy matrix. We tested in a ridge E. of the large excavation and found clayey hard digging for 3-4' even where the surface looks pebbly. In one place we came into loose gravel at 3' but in another did not get through the clay at that depth.

Aug. 12, Wolverine, Mich. Gravel on R. H. Gunning??? land So. part of NE $\frac{1}{4}$ Sec. 13 T 33 R 3 W has small pockets of good gravel 60-90% that runs in deepest part 6' or more but has small extent. One strip 20x80' has at least 6' in deepest part and average about 3'

27)4800)175 yards
27
210

Another 45x60 is over 6' in deepest part and will probably average 3' - = 300 yds. West of here an E. facing slope has gravel testing 50% from 3-6' from surface and the bottom not reached - area not determined. An old pit 30-40 rods W. of these knolls has a small amount of good gravel at its No. side. Probably 500 yds. can be obtained on the Gunning??? place by using all that we have tested. Mr. Gunning??? thinks ridges farther E. and So. are sandy. Dr. Wagar's land W. of road near So. side NW $\frac{1}{4}$ sec. 13 has a somewhat sandier gravel testing 55-70% that runs from 3' to 6' or more over an area over 100' long and 30' or more wide. It thus appears to have more than we found on the Gunning place. Dr. Wagar is a physician in Wolverine.

We went next to a place in NW part of sec. 13 close by the W. Branch of Sturgeon River on E. bank where gravel has been obtained but we find it of sandy sort much less than 50% gravel. Clear sand is struck at 2-5'. This is on a terrace 40' above the stream.

Algonquin Shore

Across the river in secs. 11 & 12 and 14 is an old river plain 60-70' above the river. This extends into the W. part of Wolverine village and also No. across secs. 1 & 2 to the river in sec. 36 T 34 R 3 W. There were small island-like strips in this plain W. of the present stream, one directly NW of Wolverine in E. part sec. 1, the other in SE part sec. 36. This plain is likely to be in harmony with the highest level of Lake Algonquin whose shore is about 4 $\frac{1}{2}$ miles No. of Wolverine in sec. 14

T 34 R 3 W. It has deep basins in it. We drove to a gravel pit in the valley of West Branch of Sturgeon River opposite the town hall and south of the stream in the SW part of sec. 14 T 33 R 3 W. This has about 6' of good gravel below which in places a fine sand was found in the test pits we made.

Opposite town hall a pit at north end has good gravel at 2-2½' from surface of gray color running 60%. It was tested 5' lower and was still good quality. A pit 100' east from here was in sandy material to depth of 5' and at that depth tests 40%. This is better than nearer the surface but none is fit for use. A test pit about 75' from north end of pit has sandy material nearly 5' but there good gray gravel testing 65% is entered.

On a higher ridge 40 rods north of the pit there is a sandy gravel that was used in grading the road from here north to the river bridge and found to be too sandy. Its best parts are only about 40%. The matrix is a brown sand to about 5' below which it is of gray color. We tested it to 10 or 11' from level of top of ridge in the slope of the cut by the road.

A test pit 5½' deep directly east of the main gravel pit 60 or 70' tests 65%. There is 2-2½' of loamy cover below which is a clean gray gravel as deep as dug. At So. side of the main pit good gravel is about 5' thick. It has a foot or more of loamy cover. At base there is fine sand. About 200' east of the main gravel pit a test hole 6' deep reached no good gravel. It was earthy loam 2½-3' and gray pebbly sand below. A test hole 100' SE of the main pit gets into good gravel 70% at 2' and does not reach the base at 5½'. One So. SE and equal distance from the pit is in sand 2-2½' below which is gravel running about 80%.

The gravel may extend east or SE further than we tested out but it does not seem to extend NE or north. We made some tests on the higher part of this bottom NE of the pit and found sand several feet deep with very little pebbly material in it. We went to some small gravel pits on N. side of the road about 3/4 mi. S. of the town hall. There is a small amount of gravel of fair quality in one of the pits running 2' or more below its base but in the other the gravel seems to have been entirely removed.

Notes Near Topinabee

Aug. 14. I went to the high ridge or bluff W. of Wolverine in which the road cuts 15-20' at top. This exposes bouldery sandy loam 3-5' below which is fine sand in distinct laminated beds - some very fine sand. It looks like the deposition had been in water outside the ice and then the ice advanced and made a thin coating of bouldery material.

I went to Topinabee to spend Sunday with Mr. Burnham of Ann Arbor. We went N. from Topinabee to a gravel ridge or shoreline directly N. of the resort at an altitude nearly 100' above the lake. The gravel is about 6' thick beneath which is sand. This is along the brow of a steep cut bluff and has scarcely any relief above land back of it to the NW.

There is a gradual rise back from here to an old island of Lake Algonquin in NE part sec. 19 and SE of sec. 18, Burt Twp. The E. slope of the island extends a few rods into secs. 17 & 20. There are gravel pits on sharp points on the E. slope of this island in SE part of sec. 18 at a level 30 to 40' above the highest shore of Lake Algonquin. The gravel seems to be in pockets and has much sand in it and is nearly clear sand under it. Two screening outfits are here in 2 pits already

opened. There are test pits showing gravel on other neighboring points. This gravel in the pits that are worked is largely of limestone but I see a few of the Lake Superior sandstones with pink color varied with bluish green spots.

In Topinabee Mr. Burnham has seen the Petoskey stones on beach of Mullett Lake. He also has collected several small boulders or large cobblestones of the red jasper conglomerate from W. of Georgian Bay.

Gravel Near Wolverine

Aug. 15, 1921, Wolverine, Mich. I went with Mr. Whitaker and assistant to S. end of the highway at county line and examined a pit on Mr. Perkins' land in NW $\frac{1}{4}$ /SE $\frac{1}{4}$ Sec. 34, Wilmot Twp. He has sold about 250 yds. from it of good quality 60% or more. There is not much more than that remaining in the part uncovered. It is doubtful if more than 500 yds. can be obtained without having a lot of stripping of sandy cover. The part now uncovered had 2-3' of sandy material over it. It was estimated at the time this was uncovered that an area 100' square is workable.

We dug pits in this pit in its bottom and in the slopes and found it will not average over 2-4' of gravel and not that much that will run 60% or more. Mr. Perkins got 25¢ a yd. for what he has disposed of.

Mr. Perkins' well at his house is 190' and has only 18' of water. There is a strong supply. The altitude is probably nearly 200' above West Branch of Sturgeon River. There are points in this vicinity about 50' higher than at Perkins' house. There is a small gravel pit in W. part of sec. 26 on a slope E. of the road. We tested in the edges of this pit and found the gravel only 4' thick. We tested at several places further up the slope and N. of the pit on other points but nowhere found

gravel over 4' thick and in places there is sandy cobbly material instead of gravel. This is a brushy stumpy hillside that will not be easy to work. Probably some use of this can be made for the maintenance of the highway as it is right beside it but it is of doubtful value in construction.

We next went to a place where there is some gravel on a nearly plane tract 80 rods N. of this highway near the line of secs. 28 & 30. There is an acre or more here that looks gravelly. We made 2 test holes 4' deep. One was in gravel of good quality testing about 60% to 3 $\frac{1}{2}$ ' below which is sand. The other was in a more sandy material from top to bottom. The best will not run more than 40%. This area is not very attractive or promising as it is full of brush and stumps and does not seem to have much good material.

We made 2 pits in the east branch valley N. of the river in W. part sec. 14 and entered water at 3'. There is good gravel in one to that depth but in the other only 30' away there is cobbly sandy material of less value. We thus seem to have found no promising prospects for road material, the best being opposite the town hall in SW part of sec. 14 and this is not likely to furnish enough for a full mile of the highway. The deposits found in sec. 12 will scarcely cover 1/2 mile of highway.

We were told by Mr. Mathew who lives in NE part sec. 34, Wilnot Twp. that gravelly deposits occur in a prominent hill in north part of sec. 36 but the distance is 2 miles by the course of the road to this highway and over a hilly tract difficult to haul gravel. It thus seems scarcely worth visiting. Mr. Mathews have has never tested the depth or extent or character of this gravel deposit.

Aug. 16, 1921. We tested at the place E. of the town hall and found gravel under about 3' of sand about 300' E. of the present gravel pit along the old railroad grade. Farther E. the ground is higher and in a pit I dug it was 4 $\frac{1}{2}$ ' through sand to top of gravel. The gravel tests about 65% and is fine to medium in size suitable for use on roads with very little oversize. This land is owned by Almond?? Jones of Wolverine.

We next went to a brushy tract in SW $\frac{1}{4}$ of sec. 15 S. of the river on a terrace about 25' above the stream and found gravel exposed over a considerable area by upturning of roots of fallen trees. We dug into it and found gravel in the first pit runs 85% nearly all fine stones less than 2" and mostly less than an inch in diameter.

The owner of this land is an Ohio man. This is about 80 rods from the road and 100-200 from S. side of the sec., or a little N. of center of SW $\frac{1}{4}$ sec. 15. A second pit 100' farther E. tests 60% at 3-3 $\frac{1}{2}$ '. It has 2-2 $\frac{1}{2}$ ' of loamy cover.

Gravel in Small Amount Suitable for Highway Use

One 200' S. has 5 $\frac{1}{2}$ ' of good gravel testing 80% below which is a fine quicksand. Its lower foot of gravel contains many stones oversize 4- $\frac{1}{2}$ " in diameter. There is 1 $\frac{1}{2}$ -2' of loamy cover on the gravel here. The gravel has a matrix of sharp gray sand. Another pit W. of the middle one 75' has but 2' of good gravel under a coating of loamy material. Beneath the gravel at depth of 1 $\frac{1}{2}$ -4' from surface, sand is entered.

The gravel of suitable character for use may cover an acre or more and yield enough to gravel a mile or more of the highway. It seems to be as extensive as that E. of the townhall in SW corner of sec. 14. The 2 deposits may be sufficient to gravel 2 miles of the

highway. All the other deposits located near the highway will scarcely cover a mile of highway, unless it be the gravel in the stream bed of West Branch of the Sturgeon. There is a lot of good gravel in its course through sec. 14. In secs. 12 & 13 so much has been taken out that the stream bed now has a larger percentage of coarse stones. Mr. Whitsker doubts if it will have much value for use on the highway.

I wrote to A. H. Jacobson, Co. Road Commissioner, giving main results of work. Aug. 17. I took MG train to Waters and there examined hills E. of the station 1/2 mile or more. I find a hill N. of the road in SE part of the Henry Stevens' farm near line of secs. 28 & 29, Otsego Twp., has gravel of good quality in crest and slopes. I dug into it 3' or more near the crest just E. of the fence on E. side of the Stevens' farm without reaching the bottom, and 3' inside the fence on the slope also in good gravel. A rain came up to stop work. This hill is about 30' high and very sharp so it covers scarcely an acre. Perhaps John White of Otsego Lake can test it further. He is the Fire Warden of this township. There is some good gravel on his land in S. part of sec. 8 as noted in a former trip here in July. The Henry Stevens' farm is now the property of the Otsego Land Corporation. The hills W. of Waters are reported to have boulder clay at top. There is an exposure of sand on the slope below Waters (south) 1/2 mile extending to height of 30' or more.

In Jackson County Aug. 20 - Sept. 10

See Notebook 274 for work in Jackson County. Work for Highway Dept. was discontinued Aug. 20, and arrangements made for cooperation between U.S.G.S. & Mich. Survey in surface geology mapping. (See Notebook 274 for notes on field work Aug. 22 - Sept. 10, 1921) in Jackson County.

Features Near Byron, Michigan - Well Data

Sept. 12, 1921. Ann Arbor, Mich. I took train on Ann Arbor RR to Byron, Mich. to work on surface geology of Durand quadrangle. At Byron station and westward from there in W. part of secs. 22 & 23 and S. part of secs. 15 & 16 there is a strip of undulating till S. of which is a swale that drains in part eastward across sec. 23 and in part westward across secs. 22 & 21, Burns Twp. The swale has very little evidence of glacial drainage - part of its bed is till and part has patches of sandy material. The undulating strip is mainly clayey till but in NE part of sec. 22 a short E - W ridge has a gravel nucleus and has been opened for road use. There is a cover of clayey loam several feet thick that makes it hard to get at the gravel.

Well Data

The prominent tract in SW $\frac{1}{4}$ of sec. 22 and NW $\frac{1}{4}$ of sec. 27 has only gentle swells on it. A well recently sunk at Mr. Meier's in NE corner sec. 27 at altitude 900' is 100' deep. It penetrated about 15' of blue clay just before striking the water bearing gravel. To a depth of about 80' there was yellow clay and some sandy material. The head is about 865' A.T. or 35' below well mouth.

I crossed to N. side of Shiawassee River on line of secs. 14 & 15. At the crossing of the E-W road N. of the river are low gravelly knolls and there is gravelly loam to the W. From here with plane surface except for draws and depressions. It occupies the SW $\frac{1}{4}$ sec. 15 & 16 and all of sec. 9 except about 100 acres in E. part standing above the 850' contour. There is strong moraine in NW $\frac{1}{4}$ sec. 10 and NE corner of sec. 9 with many boulders and with small hummocks.

Features Near Byron, Mich. - Gravel for highway use.

The S $\frac{1}{2}$ sec. 10 has some till and some sandy ground and is nearly plane. In sec. 4 there is gravelly land on S. edge. But with 40-80 rods N. boulders are numerous enough to be in piles in fields. The land seems to be gravelly and the boulders are mainly small stones less than a foot in diameter. The N $\frac{1}{2}$ and the SE $\frac{1}{4}$ of sec. 4 have large boulders and there is considerable clayey till. The moraine is weaker in secs. 3 & 4 than in sec. 10. It is also weak to the E of sec. 10 and has fewer boulders. It covers much of secs. 11 & 12, Burns Twp. and there are small knolls in N. part NW $\frac{1}{4}$ sec. 13. Van Riper hill in sec. 7, Argentine Twp., Genesee County is a gravel hill and gravel has been taken from its N. end enough to cover 6 miles of road, I am told. There is likely to be enough to cover several times that amount of road. There is a lot of flat clay land S. of this hill in sec. 16, Argentine and sec. 13, Burns Twp. The moraine lies mainly in S. part secs. 7 & 8 and in sec. 17, Argentine Twp.

The village of Byron is on till that is gently undulating. In the N. end of the village gravel is obtained in a side hill exposure under 10-15' of clayey till. There are very few boulders in this till.

Well Data

A well at Mr. King's in N. part of Byron in SE corner of sec. 14 is 122' and is on rock at bottom. It may have gone through some soft rock. It does not flow and Mr. King knows of no flowing wells in or near the village.

Sept. 13, 1921. Byron, Mich. I went by auto over the district between Byron and Denton zigzagging a belt 2 or 3 miles wide and making a distance of about 50 miles. There is nearly plane till N. of Shiawassee River in sec. 13 and 24, Burns Twp. and secs. 18 & 19, Argentine Twp.

There is a sandy gravel plain between the 2 branches of Shiawassee River in secs. 24, Burns Twp. and 19, Argentine Twp. In sec. 30 the till is near surface and there are boulders scattered over it. In sec. 20 there is a sandy gravel plain extending E. to Myers and McKane lakes. N. of Shiawassee River in sec. 30 there is a gravel plain up to about 860'. The N¹/₂ part of the sec. is morainic and so is much of sec. 17, Argentine Twp. The moraine has considerable clayey till and a moderate number of boulders. The moraine covers the N¹/₂ of sec. 21 and NW part of sec. 22. The E. part of sec. 22 and W¹/₂ sec. 23 have a nearly plane surface with a clay subsoil. The surface is in places cobbly and coated slightly with sand or gravel. There is gravelly land in SE part of sec. 22 and central and west parts of sec. 26 and E. part of sec. 27. But the SE part of sec. 26 has a very sandy loam and scattered boulders. This extends into SW part of sec. 25. The surface is gently undulating. This sort of land extends S. to Lobdell Lake in secs. 35 & 36.

Features in South Part of Durand Quadrangles

There is more prominent land in SE part sec. 25 and NE of sec. 36 that continues eastward over secs. 30, 31 & 32, Denton Twp. This is more bouldery than the lower land around it. The drift is on the whole more clayey. It looks to be a detached part of the great moraine in Tyrone Twp., the interval being filled in with glacial outwash gravel in secs. 4, 5, & 6, Tyrone Twp. It may, however, find its correlative in the relatively weak moraine that runs W. through Cohoctah from sec. 2, Deerfield Twp. In that case the land SE of Lobdell Lake should be included in the ice border though not sharply morainic. It is a gently undulating sandy loam with a few boulders being of similar character to the land N. & W. of the lake. There is a rather sandy tract W. of Linden

in sec. 19 and N. part of sec. 30, Fenton Twp. & N. part of sec. 24 and NE of sec. 25, Argentine Twp. through which Shiawassee River has a very sinuous course, some of it is sandy loam with a few boulders but more of it is sandy gravel.

Esker?

I could not get to the ridges in E. part of sec. 23 and NE of sec. 26, Argentine Twp. that look sharp enough to be an esker chain. I got a view of the one in NE part of sec. 26 from the road in N. part of sec. 25. From that distance it looks to be an esker. There is swamp in much of the E $\frac{1}{2}$ sec. 23 in the midst of which these ridges rise up sharply. There is morainic topography in secs. 16, 17, & 18, Fenton Twp. and secs. 12 & 14, & 15, Argentine Twp., a continuation of that that runs N. of Byron. From Linden I went N. across it to line of secs. 8 & 17 and then E. to corner secs. 8, 9, 16, 17 and S. on line of secs. 16 & 17. There is a narrow strip of sandy gravel S. of it in secs. 20 & 21 through which Shiawassee River flows. South of Linden in secs. 28 & 29 is a gently undulating till tract more clayey than that around Hobdell Lake. There are a few boulders scattered over it.

Features NW of Fenton in Holly Quadrangle

In the Holly quadrangle I examined a few secs. N. & S. of Fenton. There is undulating till on the E. side of Silver Lake in sec. 27 and a flatter till E. of it into W. edge of sec. 26. The greater part of sec. 26 and sec. 23 are sandy gravel and it extends into SW part of sec. 24 and NW of sec. 25. The E. & W. parts of sec. 24 are gently undulating till and this characterizes the E. part of sec. 25 and central part also. A sharp sandy ridge crossed in the line of secs. 24 & 25 marks the border between till on the E. and sandy gravel on the W.

There may be a strip of sandy gravel running across N. part of sec. 34 and SE of sec. 27. I found such a deposit in the NW part of sec. 34 at the S. base of a gently undulating till tract that occupies the remainder of the section up to the base of the prominent moraine that touches the SE corner of the sec. On the return I took road W. from sec. 34, Fenton to center of sec. 32, crossing the canal cut by the Cement Co. from Marliff Lake to Silver Lake.

Features in South Part of Durand Quadrangle

I turned S. on a prominent morainic hill in sec. 32 and came into an outwash plain of sandy gravel near S. side of this sec. This occupies secs. 5 & 6, Tyrone Twp., except the swamps and the S. edge of an undulating till that comes into N. part of sec. 6. This as indicated above may connect the Cohoctah moraine with the prominent moraine in secs. 31 & 32, Fenton Twp. This weak moraine passes between Lobdell and Bennett Lakes and then runs westward from Bennett Lake past Deer Creek village and Cohoctah station.

Around Argentine village there is a till plain with sandy loam soil. This extends NW to Myers Lake. West from Myers and McKane Lakes as noted above, there is a plain of sandy gravel extending down Shiawassee River to its junction with the So. Branch at Byron.

There is a plain of sandy gravel N. of the lower end of So. Branch as far S. as the NE part of sec. 26, Burns Twp.

The greater part of secs. 26, 25 & 26, is very level till with a few boulders. The soil is clay loam. The Cohoctah moraine lies in N. part of Cohoctah Twp. as far W. as sec. 33, Burns. It there enters Burns Twp. It is rather diffuse in secs. 1, 2, & 3, Cohoctah Twp. and N. part of secs. 10, 11, 12. But boulders are a conspicuous feature and there are numerous piles in the fields.

Features near Linden

Sept. 15, 1921. Ann Arbor to Durand on AARR, and Durand to Linden on GRR. The moraine and till plain are pretty clearly recognizable and distinguished in vicinity of the GRR and indicated on Durand sheet. There is till from Linden station to Linden village with nearly plane surface and few boulders.

The dam at Linden is about 12' high on Shiawassee River. S. of Linden morainic topography sets in SE part of sec. 20. Nearly all of sec. 29 is morainic there being moraine on N. side of Byron??Byron?? and Pine Lakes. It is knolly and bouldery. There is a narrow strip of sandy gravel along the highway SW from Linden in S. part of sec. 19 and N. part of sec. 20, Denton Twp. but in places a sandy loam with occasional boulders comes to surface.

A gravel pit has been opened in SE part of sec. 24, Argentine Twp. with excavation 12' deep. The greater part of SE sec. 24 is gravel plain and the N. part of sec. 25. The SE part of sec. 25 is morainic and a morainic spur runs SW between arms of Lobdell Lake in NW part of sec. 36. W. of this in NE part of sec. 35 is a spur that is high but only gently undulating. It is 35-50' above the lake. While the spur in NW part of sec. 36 is from 25 to 30 ft. above lake level. These spurs seem to be clayey till. There is sandy loam in a depression in N. part of sec. 36. The prominent ridge in E. part sec. 31 that catches the 1000' contour has a clayey till on its crest and W. slope but the E. slope is looser textured. The crest of this ridge is smooth and it looks like it might be an overridden ridge that was formed before the time of the Cohoctah moraine and then covered by a readvance of ice at that time.

Features in SE part of Durand Quadrangle

There is a gravel plain W. of Marl Lake that takes in ground as high as 920' contour. E. of the lake is a till plain with numerous

boulders and stiff clayey soil. This extends N. in sec. 33, Fenton Twp., to the border of the basin in which Silver Lake lies. It is about 910' A.T. or a little lower than the highest part of the gravel plain W. of Marl Lake. It has the appearance of being a line of glacial drainage in which there was cutting instead of filling.

The rise into a moraine S. of it is in places steep and bluff-like as if the drainage had cut into it. At the road intersection in W. part sec. 35 there is a gravel pit opened in a morainic knoll. I went W. here 1/4 mile, then N. through fields along line of secs. 34 & 35, 26 & 27, for a mile. There is till in this line nearly to the sec. corners but for 1/4 mile N. and 30 rods S. there is sandy gravel and the surface is a little lower than the till. This low strip runs WSW to Silver Lake. I crossed it in NW part of sec. 34 on Sept. 13. With the exception of the sandy gravel after crossing a swale 1/4 mile from W. line. There are sand ridges on the brow of the S. bluff of Shiawassee River in NE sec. 26 rising 4-8' above the plain S. of there. I turned S. in E. part of sec. 26 and rose slightly at the Catholic cemetery to a bouldery till. There seems to be till at slight depth S. from there.

The plain in S. part of Fenton is below 920'. That contour follows the foot of the steep slope of the moraine. There is an abrupt rise to about 970-980'. At the county line of Genesee and Livingston a steep ascent begins at 930' to a very prominent hill 1158' on E. side SE $\frac{1}{4}$ sec. 2, Tyrone Twp. This has boulder piles on its N. slope. There is a weak moraine on N. side of Shiawassee River E. from Fenton. It is visible for a mile or more westward from the river bridge near the G. T. depot. It is 920-930' A.T. and is composed of clayey till with a moderate number of boulders.

Features Near Long Lake

Sept. 16, 1921, Fenton, Mich. I get an auto and drive W. a mile

then north. I find sandy gravel clear to shore of Long Lake in S. part sec. 14 as well as in sec. 23. In sec. 15 and the part of sec. 14 S. of Crane Cove of Long Lake there is a better soil, a sandy loam with a few boulders. This sort of land lies both N. & S. of the N. part of Squaw Lake (the part in the Holly quadrangle). There is morainic topography in the S $\frac{1}{2}$ sec. 10 and N. edge of sec. 15. The drift is largely clay loam there being more clay in it than in the gently undulating tract S. of it. The till plain N. of this moraine in N $\frac{1}{2}$ sec. 10 and in secs. 2 & 3, has a stiff clayey till. The sharp ridges between Long Lake and Barnum Lake in sec. 11 are also a stiff clayey till and so are the ridges and knolls in secs. 12 & 13, Denton Twp. I drove NE across sec. 12 and N. into sec. 1 Denton, over morainic surface with clayey till.

Features N. of Denton

The sharp ridges in SW part of sec. 1 are not eskers but are largely clayey till. The roughness of surface in sec. 1, Denton and in secs. 6 & 7, Holly Twp. is due to depressions below the general level rather than knolls and ridges above the level. When on the higher ground it looks nearly plane. It is a stiff clayey till where I travelled eastward in sec. 6 and southward through sec. 7, Holly Twp. The morainic land in NE part of sec. 10, Denton, has mainly clayey till. The looser textured till sets in S. of Crooked Lake.

Features SW of Denton

I returned to Denton and went SW on the road called "Ann Arbor" road across a moraine to Denton Creek valley. The moraine is largely clayey till in the road cuts. There is sandy gravel in the lowlands bordering Denton Creek up to 950'±. It is not graded up to a plain except in a narrow strip where the White Lake Road crosses the Ann Arbor road that stands 950' A.T. I went SE in the White Lake road to the Oakland Co. line through a morainic tract S. of Denton Creek.

I come into a smoother till tract in sec. 18, Ross Twp. In secs. 7 & 18 S. part of sec. 8 and N. part sec. 17, there is a very bouldery tract with heavy soil, stiff clayey till. The boulders are mainly small ones less than a foot in diameter. To the N. of these secs. there is looser textured drift and morainic topography in secs. 5 & 6, Ross Twp. and sec. 32, Holly Twp. I crossed this in secs. 5 & 6, Ross Twp. and from there returned to Fenton.

Features near Holly

I took train Fenton to Holly at 10:47 A.M. This makes slight cuts in till 1/2 mile and 1 mile E. of Fenton, otherwise it is in the glacial drainage channel that I traced some years ago from near Ortonville to Fenton. Holly stands on the S. side of this drainage channel. The NE part of sec. 33 and NW of sec. 34, Holly Twp. are sandy but the SE of 33 and SW of 34 are till except where wet and covered with muck.

From the S. part of the village I get a view of morainics to the W. in secs. 4 & 9, Ross and sec. 33, Holly and to the S. in secs. 1, 2, 3, 10, 11 & 12, Ross Twp. These have strong expression though there is a more gently undulating narrow strip traversed by the Pere Marquette RR in secs. 4 & 9, Ross Twp. with loose textured drift. I went E. on the Pontiac Road crossing a strip of low muck land in central part of sec. 34 E. of which is a sandy gravel up to the 930' contour and nearly to 940'. Above the 940' contour there is a bouldery till ranging from clayey to loose textured gravelly material. It is gently undulating and seems classifiable as ground moraine. There is, however, a strip of knolly land running from near center of sec. 36 southward across NE part of sec. 35 and SW of sec. 36, Holly Twp. The remainder of secs. 35 & 36 is ground moraine. There is some morainic topography in sec. 31, Groveland, but most of that sec. and S. part of sec. 30 have a peculiar "badlands" topography due to erosion which is exceptional on account of the presence

of sand beds between thin beds of clay. The amount of sandy material seems to be greater than that of the clayey.

Features in SW part of Holly Quadrangle

A few knolls in NE part of sec. 31 rise a few feet above the general level, but much of the area is nearly plane. There is a strong moraine to the SE in sec. 32 and to the N. in sec. 30. To the S. is a strong moraine running southward from secs. 8 & 9, Groveland, along the E. side of the Holly quadrangle into the Milford and Pontiac quadrangles.

In sec. 29, Groveland, there is considerable nearly plane land part of which is clayey till and part a sandy gravel. This smooth low strip runs W. through E. part of sec. 19 and $\frac{1}{2}$ of sec. 20 to the glacial drainage channel in sec. 16. I went through this on line of secs. 29 & 30. There are narrow channels coming together near $\frac{1}{4}$ post of secs. 29 & 30 - one from the NNW and the other from WSW and a shallow depression runs E. across sec. 29 just below 1000 foot contour. This is sandy gravel and so is the land bordering it up to about 1010'.

From Cottage Corners W. to Five Points I crossed a moraine on line of secs. 19 & ~~29~~ 30. W. of this is mainly a clayey till plane to Five Points. There is some sandy gravel NE of Burns Lake. The glacial drainage above noted passes Five Points on the W. and there is a strip of sandy gravel from there to Holly. I took the Pere Marquette train at 2:17 P.M. from Holly to Flint. This is in the glacial drainage channel to the SW part of sec. 22, Holly Twp. There low bouldery hummocks scarcely 10' high mark the moraine which determined the course of the glacial drainage. The moraine varies greatly in strength as may be seen by reference to the contours on the Holly map. It seems to extend into secs. 26 & 27, Grand Blanc Twp. and then runs eastward across S. part of Atlas Twp. to the E. limit of the quadrangle. It passes $1\frac{1}{2}$ -3 miles S. of Goodrich.

Features in North Part of Holly Quadrangle

There is another moraine running through Grand Blanc to the NW corner of the Holly quadrangle. This runs westward across the central part of the Durand quadrangle passing through Gaines and 2-3 miles S. of Durand.

I watch for the "Thread Lake Esker" (of Taylor's) between Grand Blanc and Flint. There is not a definite esker except perhaps between the Atherton Road in SW part sec. 20, Burton Twp. and the Grand Trunk cut-off in NW part of sec. 19. There is some undulating sandy gravel in central and NW part of sec. 29, Burton Twp. There are gravelly knolls and ridges of irregular shape in W. part of sec. 33. There is also gently undulating loose textured drift at a cemetery E. of Gibsonville in SE part of sec. 4, Grand Blanc Twp. Aside from these places the land seems to be clayey till from the Grand Blanc moraine to Flint. On reaching Flint I took the Lakeside car S. into the E. part of sec. 19, Burton at Lincoln School. I then mapped the sandy land in sec. 19 and adjacent parts of secs. 20, 29 & 30.

Features South of Flint

There is a strip of sandy land E. of center of sec. 19 running S. past the Lincoln School that is not related to the esker. It may be a feature of Lake Kersley. It is a sand with a few pebbles scattered through it and it seems to be only 3 or 4' deep and rises that much above bordering till plain. W. of this along E. side of the Pere Marquette tracks is what Taylor calls the Thread Lake Esker. It has gravel and sand extending down to about the level of the Pere Marquette tracks which are 15-20' below the plain E. of there. The ridge has been largely removed its entire length and nothing now remains that stands 5' above the plain to the E. The gravel and sand seem to be banked against the till. The land W. of the Pere Marquette RR has no sand and gravel at

levels corresponding with that E. of the RR but has a clayey till at surface.



In the depression at S. end of Thread Lake there is a short winding ridge of sandy gravel of esker type. It is lower than the general upland to the E. and S. This is in SW part of sec. 20, Burton Twp. There are deposits of sandy gravel in SE part of sec. 19 that are opened 12-15' deep. This also seems to be banked against till N. of it. There is more or less sandy gravel on the plain from here SE past the center of sec. 29. This deposit classed as an esker in sec. 19 and SW part of sec. 20 has very little gravel now exposed. Much of it is sand with only a few pebbles in it.

There are pits at N. edge of the Holly quadrangle each side the N-S quarterline road which show gravel in beds dipping southward and alternating with beds of sand that is very slightly pebbly. The bedding is very discordant parts of certain beds having been cut away and beds of a different degree of coarseness built over the remnants. The part of Thread Lake S. of the park is known as "The Inlet". It has been sounded and found to have about 25' of mud, marl, etc. The main lake N. of the park has a gravel and sand bed at depth of 2 to 5' for some distance N. and "hard pan" probably till at N. end. It is planned to dredge out the mud and make a clear lake that will be a beauty spot instead of a nuisance as the present foul smelling marshy lake is.

It is the plan of the city also to acquire the frontage on Flint River for park purposes and have a boulevard along the stream in its course through the city. I am told at the city engineers' office

that the only part of the city with much sandy surface is in sec. 5, Burton Twp., E. of Flint River. There is some sand in the south part of sec. 20, Burton, and N. part of sec. 29 as shown by street excavation. The sand may cover considerable ground in S $\frac{1}{2}$ sec. 20. A rain having come up I return to Ann Arbor via the Pere Marquette to Northville and by electric to Wayne and Ann Arbor.

Glacial Drainage Channel near Parma

Sept. 19. I went by electric car Ann Arbor to Parma. From Parma I went NE and N. through sec. 30, Sandstone Twp. across a bouldery plain with a loose textured subsoil. It seems to have been current swept as high as the 970' contour. The channel, however, is below 960' and the wet part probably has a solid bed as low as 950' as was noted in my studies early in Sept.

The main channel comes in through sec. 29 from secs. 28 & 33 and turns W. in south part of sec. 19. There is a narrow channel along McKay Brook in sec. 20 that shows current action to about the 950' contour. There does not seem to have been a drainage course from the Howe School S. into McKay Brook for there are knolls and bouldery ridges in sec. 17 blocking the course to the swamp in N. part of sec. 20. East of the prominent group of morainic knolls in SE part of sec. 11 there is a bouldery stream plain a little below 950' that has gravelly loose textured subsoil like that NE of Parma. It is a stony gravelly loam.

The low plain along Sandstone Creek has a gravelly soil and stony concentrate. This is below 930' contour and seems too low to connect with any glacial drainage that runs W. from Sandstone to Rice Creek N. of Parma. The dry land W. of Sandstone Creek in secs. 5, 8 & 17, is said to be "clay and gravel mixed". There is an outcrop of sandstone where road rises to the E. on line of secs. 20 & 29, Sandstone Twp., up to nearly the 980' contour.

Mainly in East Part of Springport Quadrangle

The high land in sec. 16 and S. part of sec. 9, Sandstone has remarkably hummocky surface. To the N. of it occupying much of sec. 9 there is a gently undulating ground moraine with a moderate number of boulders, and loose-textured drift. In sec. 4 is another area with numerous sharp hummocks and sandy drift with moderate number of boulders. The sharp ridge E. of the Springport-Jackson highway from Robinson school northward is very sandy. It is not a typical esker and seems likely to be merely sharp morainic ridge.

I followed the Springport-Jackson highway SE to Jackson. It is in strong moraine to the SW part of sec. 11 with sharp hummocks and loose-textured drift. A gently undulating ground moraine is entered near the line of secs. 11 & 14. This covers secs. 1, 12 & 13, Sandstone, but there is morainic topography in S. part sec. 14 and also in NW part. This till plain has numerous boulder piles and stones of all sizes seem to be fully as numerous as on the sharply morainic land. There are only a few sharp knolls in secs. 23, 24, 25 & 36, Sandstone Twp., the greater part being gently undulating loose-textured ground moraine. This sort of topography characterizes the part of Blackman Twp. W. of Grand River though there is an area of over a mile of low mucky land in sec. 8 N. part sec. 17 and NE sec. 18.

A considerable part of sec. 29 and adjacent parts of secs. 20, 21 & 28, also have numerous hummocks. This morainic topography extends E. to Grand River valley in secs. 27 & 34. There is considerable plane or gently undulating in secs. 31, 32 & 33, Blackman Twp. The moraine that is so strong E. of Grand River is very diffuse and vague to the W. in this twp.

On Railway from Jackson to Stockbridge

I took train on Grand Trunk RR from Jackson to Stockbridge. This route had been covered as far as Portage River in earlier trips about Sept. 1 when studying the land of the Wisconsin farms. The knolls each side the RR within 1/4 mile N. of Portage River have a few boulders but the drift is very sandy. The same is true of the knolls in central and NW part of sec. 4, T 2 S, R 1 E. What little flat dry land there is, is sandy. The knolly strips in secs. 27 & 34, T 1 S, R 1 E W and SW of the Henrietta esker look like a strong morainic feature and so do those E. of Henrietta Station. The esker indicates an ice movement southeastward but there is not a definite morainic ridging at a right angle to this course.

The esker has been opened for gravel on N. side of the RR. In secs. 14 & 23 there is a gently undulating till or ground moraine topography and a loose textured drift with a few surface boulders. This continues past Munith village to within about ~~2 1/2~~ 2 miles of Stockbridge. There is a small winding gravelly ridge of esker type in NW part of sec. 8 with a gravel pit in its S. end. In sec. 4, T 1 S, R 2 E and eastward across secs. 3, 2 & 1, there is a hummocky morainic tract. It extends a little into Ingham Co. in secs. 34, 35, 36 (S. part). Between this and Stockbridge there is a flat strip largely wet land but with some dry land of sandy gravel.

From Stockbridge depot westward across sec. 27 there is a knolly bouldery strip. The village is in a plain of sandy gravel except a small area in SW part that is undulating till. This deposit of sandy gravel is thin in places with yellow till beneath. It extends about 1 1/4 miles E. of Stockbridge into the W. part of sec. 25 as noted in a trip in July. It extends NW to Nichols Lake in sec. 23 and covers the SW part of sec. 24, Stockbridge Twp. Portage Creek traverses it in a SE course and is bordered by wet land. There is a plain of sandy gravel on the

SW side of the creek embracing most of the dry land in secs. 26 & 35.

On Bus (stage) Stockbridge to Bunker Hill & Jackson

I took stage to Bunker Hill and Jackson. The drift is a somewhat gravelly loam loose-textured and with few boulders and nearly plane surface classed as ground moraine from Stockbridge W. 2 miles to Jacobs Lake. There is a chain of sharp gravelly ridges of esker type W. and SW of this lake. Two in NE part of sec. 29 are opened for gravel. W. of this chain of ridges is a plain of $\frac{1}{2}$ sandy gravel in sec. 29 and at the N. from this road in secs. 17, 18, 19 & 20.

W. of a swamp in sec. 30 and SW part of sec. 29 there is a till plain with a stiff clayey till and flat surface. It extends into the Stockbridge quadrangle only a short distance in secs. 19, 30 & 31. This plain covers the part of Bunker Hill Twp. E. of the Cahoonen??? ditch from sec. 12 southward past Fitchburg. It has only a few boulders. Some of it requires tile draining and nearly all of it is clayey.

Features near Bunker Hill

There is a chain of gravelly esker ridges along W. side of the creek in secs. 11 & 14. W. of this in SW part of sec. 14 is a very stony ridge that catches 950' and 960' contours. It is not gravelly but seems to be a stony till. Boulders are also numerous W. from here to within 1/2 mile of Bunker Hill village. The hill S. of this is also bouldery.

The stage route is S. from Bunker Hill through a till plain diversified by occasional clusters of knolls as far as Battese??? Lake. It is a rich farming country. This covers several secs. in the NE part of Henrietta Twp. There is considerable diversity from Battese Lake to Portage River that will require detailed study to map correctly - some being clayey till and some loose textured sandy and gravelly material & some an intermediate loose textured till. There is only a small part of it of morainic aspect. On reaching Jackson I took electric car to Lansing at 9:10 A.M.

From Lansing I took GTRR to Vicksburg. The first two moraines crossed have very weak expression about like ordinary undulating ground moraine but they seem to mark positions held by the ice border in the course of its recession. The knolls around Millett are gravelly and stand in an otherwise flat till tract. A boulder strewn moraine with strong expression is entered 1/2 mile NW of West Windsor. The moraine on which Potterville stands has also strong expression and many Bs.

On Grand Trunk RR Lansing to Vicksburg

I have no map with me between the Lansing quadrangle and the Battle Creek - or Camp Custer quadrangle. I noted that boulders abound in cuts where the RR ascends the S. bluff of Kalamazoo valley to the place where it turns away from the valley in the S. part of sec. 4, Battle Creek Twp. The cuts in secs. 8 & 9 are in finer material or typical outwash. It is probable the boulders mark an ice border even where morainic knolls are not present.

From near the line of secs. 8 & 17 to Battle Creek to the N. edge of sec. 36, Charleston Twp., the railway is crossing the Tekonsha moraine around the swampy depression in sec. 30, Battle Creek, and in sec. 25, Charleston Twp., there are piles of small stones mainly less than a foot in diameter or about as small as coarse stones of outwash. The drift, however, does not seem to be outwash here but is of variable texture like the moraine and its topography is morainic.

Lake Michigan Moraine SW from Camp Custer

I saw no boulders in cuts or on slopes between Scott's and Pavillion station yet there seems to have been an ice border that encircled the N. and W. sides of the high outwash that is traversed from sec. 36, Charleston Twp., to Scott's station. This ice border correlates with the Tekonsha moraine of the Saginaw Lobe and pertaining to the Lake

Michigan Lobe as determined in previous studies in the Camp Custer area. The Lake Michigan Lobe formed a strong moraine from Camp Custer SW to the meridian of Galesburg but to the S. from there it is a weak feature.

In SE Part of Schoolcraft Quadrangle

Vicksburg, Michigan, September 21, 1921. I drive S. through a plain of sandy gravel much broken by basins for 3 miles. An occasional small boulder is to be seen in the road on line of sec. 6, Mendon, and sec. 1, Park, but the surface is flat and soil sandy. The W. part of sec. 7, Mendon and E. part sec. 12, Park Twp., have gentle undulations and occasional boulders. The drift is very sandy yet it is likely to be a glacial deposit and is a natural course for the Tekonsha moraine of the Lake Michigan Lobe. In sec. 13 boulders are very numerous on N - S quarter line road and they continue numerous to Parkville in W. part of sec. 24 and E. part of sec. 23 and SE of sec. 14. The boulders are large $1\frac{1}{2}$ -3'±. I went W. on line of secs. 14 & 23 and came to edge of the boulder strewn land near middle of sec. line. This bouldery land has very sandy loose-textured drift. Small stones in it seem less numerous than in the plains of outwash.

I find no distinct glacial drainage line at the small stream in secs. ~~15~~ 15 & 22. The high land catching 840' contour in vicinity of corners of secs. 15, 16, 21 & 22, is exceptionally sandy and seems to have no boulders so is not a definite ground moraine. There is a distinct glacial drainage channel running S. through E. part of secs. 9 & 16 and then SSW into Portage River through secs. 21, 28 & 29 & 32, Park Twp. It is 40-60 rods wide and leads away from a swamp in secs. 4 & 9 that is below the 840' contour. Some water may have come into this channel from marshy tracts in sec. 10 entering it near corner secs. 9, 10, 15 & 16. This line of discharge seems to be better defined than along the present course of drainage from Barton Lake to Portage River as that is through

a very narrow passage where the GR&I RR crosses. The stream that leads S. from near the Götterman School in sec. 8, Park Twp., does not occupy a glacial drainage channel but is in a very narrow valley of its own cutting. I turned N. on the Trunk Line Road a mile S. of Flowerfield Station and followed it N. to Schoolcraft. The road grading shows the depth of the black soil of Prairie Ronde to be 10 - 15". Below it is a loamy earthy deposit a few inches then gravel sets in.

I went E. from Schoolcraft to a channel that runs S. from the basin in which Gourdneck and Hogset Lakes lie to the basin in which Barton, Rawson and Howard lakes lie. It traverses the E. part of sec. 9, Schoolcraft, NE of sec. 16 and W. part of secs. 15, 22 & 27. It is narrowest at the N. end in sec. 9. The usual width is about 60 rods. It is wider where basins lie along its course one of which is in secs. 9 & 16. I went to the head of this channel in N. part of sec. 9. From there I went W. to the trunk line highway on line secs. 5 & 8 and then W. on it $1\frac{1}{2}$ miles and S. into Schoolcraft. This shows grading through the black prairie soil and the loam into sand. In the village of Schoolcraft sand is being thrown out in the drains at less than 3' where the soil is a rich black prairie soil. There is black color about 8 inches. Below this is a pebbly brown "hardpan" about $1\frac{1}{2}$ ' thick. It has a coarse sand and fine pebbles with a loamy matrix. It has to be loosened with pick.

Clay Capping on Outwash

I went W. from Schoolcraft through W. part of Prairie Ronde coming to the timber near corner of secs. 14, 15, 22 & 23. The prairie is on an outwash plain and the correlative ice border was where the timber sets in. This is gently undulating land with a few boulders and some clayey drift but mainly loose textured gravelly material. There is on some of the flats that stand slightly above 900' in secs. 29, 31

& 32 a sticky clay with a few cobblestones in it which is said to be only 3-4' thick and has loose sandy gravel under it. These tracts are classed as clay land by farmers and the timber is consistent with that class being beech and maple and elm with some black oak. There are scarcely any boulders in secs. 28, 29, 30, 31 & 32, Prairie Ronde Twp. I saw none a foot in diameter.

Features West of Prairie Ronde

On the line of secs. 19 & 20 there is considerable undulation but I see no boulders and the few exposures indicate gravelly and cobbly material. The N. part of sec. 17 is on gravel plain that covers nearly all of sec. 8, 9, 16, and has its continuation eastward in Prairie Ronde. The prairie extended into the NE part of sec. 9 and SE of sec. 4. The NW $\frac{1}{2}$ of sec. 4 is a clay with numerous boulders but not much undulation. It looks like till plain rather than moraine. It has a heavy growth of maple and other trees that are now being lumbered off, there being a saw mill in the NW part of the sec. I went N. on line of secs. 4 & 5 in the till and then SE to center of sec. 4 in it. I there turned E. and traversed its N. edge of an arm of Prairie Ronde through center of sec. 3.

I get a view NE over marshes in sec. 24, Texas Twp. The dry land E. of the marsh seems to be a plain of sandy gravel. I crossed it on line of secs. 34 & 35 when here about 3 yrs. ago, and noted an occasional boulder and slight loam admixture in the sandy gravel. There is also loamy soil in sec. 26 on a plain of sandy gravel. I noticed a few boulders at the SE end of Harrison Lake on line of secs. 2 & 11, Prairie Ronde Twp. today, also an occasional boulder along S. edge of swamps S. of Little Sugar Leaf Lake in sec. 6, Schoolcraft Twp. I had a view when on line of secs. 5 & 8, Prairie Ronde Twp. of the prominent moraine of the Kalamazoo system in secs. 5 & 6 of that twp. S. of Paw Paw Lake.

Features East of Kalamazoo Moraine

Sept. 22, 1921, Schoolcraft, Michigan. I went N. 2 miles, W 1/2 mile, N. 2 miles, W. $3\frac{1}{4}$ miles all through outwash plain. In SW part of sec. 26 and NW of sec. 35 cobble becomes conspicuous in cultivated fields. Farther E. the pebbles are small and material rather sandy. There are only a few acres of bouldery moraine in sec. 33 in its NW corner but sec. 32 is nearly all strongly morainic. About $\frac{3}{4}$ of sec. 28 has bouldery moraine but the SE part is nearly plane gravelly and cobbly drift classed as outwash material. In sec. 27 about 60 acres in NW corner has morainic topography and boulders. The $S\frac{1}{2}$ is cobbly gravel but the NE part is sandy with few pebbles.

Kalamazoo Moraine & Outwash in Schoolcraft Quadrangle

The E. part of sec. 22 also is sandy outwash and this extends E. across secs. 23 & 24. At Texas corners there is a dry channel leading ESE which heads at Crooked Lake and is below 910' contour. This outwash plain is about 920'. On the SE side of Bass Lake it reaches 930' and it is also 930' on highest parts in 27, 28 & 33. Its highest parts in secs. 4, 8, & 9, Schoolcraft Twp. are about 920'. There is a descent of about 40' in this plain from there to Schoolcraft village.

There is morainic topography with bouldery drift on W. side of Bass Lake but on the E. I see no boulders and an outwash plain slopes away from the brow of the E. bluff. The moraine and outwash border runs N. through the W. part of sec. 11, Texas Twp. The outwash starts at about 950' on N. side of West Portage Creek valley and within a short distance N. near line of secs. 2 & 11 is above 960'. It seems to be about 20' higher on the N. side of this valley than on the south. The chain of swamps along this stream may mark an ice border from which the outwash on the SE side was built up. Stagnant ice blocks may then have persisted here while the active ice border was at the position where the outwash from the outer Kalamazoo moraine starts in sec. 2 & 11.

Oshtemo to Kalamazoo

There are boulderets and cobblestones in the part above 950' contour in W. part of sec. 2 and a little E. of the N - S quarter line road in E. part where the 960' contour is present. W. of this road boulderets are numerous and the surface is not graded up to a plain in NW $\frac{1}{4}$ sec. 2 and SW $\frac{1}{4}$ sec. 35, Oshtemo Twp. but most of the E $\frac{1}{2}$ and a little of the NW $\frac{1}{4}$ are graded and stand above 960' contour. Oshtemo is on this plain and is 960' at cross roads and 970' a few rods E. I take the auto bus into Kalamazoo from Oshtemo on the Territorial Road. This is in the high outwash plain clear to the edge of the city. It is gravel of medium coarseness with but little cobble and few coarse stones. There is till under it exposed in some of the slopes near base. I took M.C. train at Kalamazoo to Jackson at 2:30 P.M. and electric Jackson to Ann Arbor.

Grass Lake to Portage Lake

Sept. 23. Ann Arbor to Grass Lake by electric. I went N. on W. side of Grass Lake across the outwash plain and the outer member of Kalamazoo morainic system to Portage Lake and on in the moraine to the S. end of the lake. The dry land in sec. 31, Waterloo Twp., NE of Portage Lake is a sandy plain with few if any boulders. There are a few boulders on the dry land in SW part of sec. 32 and some till. The dry land in secs. 29 & 30 is bouldery sandy till. The highest parts come up to a plain between 950 and 960' A.T. In secs. 19 & 20 the boulders are scarce and the drift much like a sandy outwash plain.

This is strikingly lighter soil than the plain a mile N. in sec. 18 which has some clayey till as noted in a trip early in July. There is sandy gravel with few boulders in secs. 19 & 21. I noticed a few boulderets in low ground in W. part of sec. 21. There are also boulderets & cobble in the sand in the low plain E. of Little Portage Lake. The N. part of sec. 28 is a plain of sandy gravel.

Features in River Jc. Quadrangle

The morainic hills in S. part of sec. 28 are loose textured gravelly drift with a few boulders. The drift is somewhat more clayey in nearly plane tracts in SE part of sec. 32 and W. edge of sec. 33, Waterloo Twp. than farther W. I got a fine view from the prominent moraine on line of secs. 4 & 5, Grass Lake Twp., of the district E & S to the high outer morainic belt of the Kalamazoo morainic system. It is a sandy gravel drift which in places looks to be up to a plain of aggradation banked along the inner face of the high moraine.

The greater part of the drift in secs. 7, 8, 9 & 10, Grass Lake, is of this sort. In sec. 3 the surface is lower and is gently undulating. I went W. on Wildcat road from near Trist and this is through this sort of gravelly drift with appearance of aggradation to definite plain on the highest parts. There are a few boulders and more boulderets & cobblestones.

I went N. on the range line past the twp. corners to the Portage marshes, W. of Portage Lake. The drift in sec. 6, Grass Lake and SE part of sec. 1 as well as secs. 11 & 12, Leoni Twp., has gravelly character with a few boulders and boulderets. It is too rolling to class as ground moraine. There is nearly plane sandy drift on line of secs. 31 & 32 W. of Portage Lake. In sec. 33 some dune sand is crossed by the wagon road in SE $\frac{1}{4}$ of sec. The dry land in secs. 35 & 36 is very sandy but there are boulders visible on the wind swept sandy slopes in the chain of knolls along the road in N. part of sec. 36 and SW part of 35. The topography is sharply morainic in the W. part of sec. 25 and N. part of sec. 26 and S. part of sec. 23. SE from Henrietta station, and there is sharp moraine to the SW in secs. 27 & 24 as noted Sept. 19. I took train to Stockbridge from Henrietta station at 4:00 P.M.

Features Near Stockbridge

Sept. 24, 1931. Stockbridge, Mich. I drive N. by auto across a clayey plain that occupies E. part of sec. 22 and NW $\frac{1}{4}$ of 23. The greater part of sec. 14 is wet land but a few hummocks are found in S. and W. parts and in E. part of sec. 15. These have numerous boulders and some clayey till. In S. part of sec. 15 and W. part of sec. 22 there is a high till plain clayey till much of it being about 960' or about 20' above the wet land bordering it. This becomes hummocky in SE part of sec. 16 and NE of sec. 21 so as to have morainic aspect.

I went N. across clayey till plain in secs. 15 & 10 into sec. 31, Stockbridge Twp. The till becomes looser textured in sec. 3. I went W 1/2 mile on S. edge of the Fowlerville quadrangle. There is a plain to the N. part the N. line of Stockbridge Twp. I came S. on line of secs. 9 & 10 to an angling road and followed it westward and northwestward across a clayey till plain into sec. 5 in SW corner of Fowlerville quadrangle. The land is a little more sandy here than in sec. 8, 9 & 10.

I went S. on line of secs. 7 & 8, Stockbridge Twp. and found a clayey till but in W. part of sec. 8 there are gravelly knolls one of which has a gravel pit. There is a somewhat clayey till as far SE as Standish Lake in sec. 17 but S. of this lake there is a sandy gravel covering the S. part of secs. 17 & 18 and much of secs. 20 & 29 and the E. part of sec. 19. There are low gravelly ridges of esker type along the E. edge of this plain overlooking a large swamp on the E. that includes Jacobs, Lyons, and Standish Lakes.

Features in Stockbridge & Rives Jc. Quadrangle

I went W. into the Rives Jc. quadrangle on line of sec. 7 & 18, Stockbridge Twp. The drift is loose textured till in W. part of these secs. and in sec. 18, Bunker Hill. There is much wet land in these secs. and nearly all of secs. 13 & 14 with a muck soil and probably sandy

subsoil. The large ditch in E. part of sec. 11 shows sand under the soil. Mr. the state surveyor thinks this land has a sandy substratum. We do not find exposures except at this large ditch.

West of this ditch is a chain of esker ridges running S. from sec. 11 across sec. 14 to N. edge of sec. 23. The W. part of sec. 14 W. of these gravel ridges is very bouldery till.

The W. part of sec. 11 and most of sec. 2 has sandy gravel soil and this continues across sec. 10 with a gentle rise to the W. At Barney School the alt. is 571'. There are no boulders on this sandy gravel so far as I can see. It looks to be an outwash tract. But there are singular irregularities in altitude - as if it involves more than one position of the ice border. Thus from E. part of secs. 9 & 16 there is an eastward slope, while on the W. there is an abrupt drop to a lower plain. This plain in turn rises gently westward and northwestward across secs. 8 & 17 to the edge of swamps in secs. 7, 12, 13 & 18, this area being known as the Felt Plain. N. from Bunker Hill boulders set in near the center of sec. 15.

I went S. from E. side sec. 15 to the Fitchburg School through a plain of clayey till. There is, however, a small gravel-ridge in the SW part of sec. 22 and one in W. part sec. 26 and another at the Fitchburg School running from sec. 26 into sec. 35 and others in W. part of sec. 35. These are separated by gaps wider than the length of the ridges in most cases so do not make a definite esker chain. In secs. 25, 26, 35 & 36 there is a gently undulating clayey till, and this kind of land embraces several secs. in the NE part of Henrietta Twp. My route took me to Fitchburg then S. to Base Line then E. into W. edge of Spockbridge quadrangle, then southward to Hunt's then E. from Hunt's to the gravel trunk line road at line of secs. 9 & 16 all through gently undulating till.

Around Pleasant Lake and Mud Lake there is a loose textured drift while to the S. of Pleasant Lake there is an outwash plain of sandy gravel which extends SW into secs. 13 & 24, Rives Twp. and covers sec. 19 and S. part of secs. 17 & 18 and W¹/₂ sec. 20, Henrietta Twp. This plain is, much of it, nearly 960'. At Leyton Corners (Henrietta village) it is 959' and the 960' contour is found where sand is accumulated to height of 2 or 3' above the general level. The plain slopes southward and ends at a swamp at about 930' in S. part of sec. 19 and SE part of sec. 24. As noted a few days ago the filling with sandy gravel along Grand River N. of Rives Jc. reaches 930' so this outwash plain slopes down to a level corresponding with that filling. There is likely to have been ponded water to the S. along Grand River and the lower course of Portage up to 930'. The influence thus is likely to be widespread in central and NE in Jackson County. The limits are marked by green line on the Rives Jc. and Stockbridge maps.

On the E. side of Pleasant Lake is an esker which runs southward along the E. side of the outwash plain just noted through secs. 17 & 20 past Twin Lakes. It is about 3 miles in length and is nearly continuous, the gaps being very narrow. Its highest parts catch the 960' contour but the southern part is below 950' and in places below 940' so it is but little above the level of the ponded waters S. of this outwash aggradation just noted. The N. part in sec. 8 has till on both sides but in secs. 17 & 20 the till is only on E. side.

In sec. 8 there is humpy till of morainic type E. of the esker but further S. in secs. 16, 17, 20 & 21 the till surface is gently undulating about like much of the ground moraine, of this region. I am uncertain as to the position of the ice border to the E. of this outwash and esker. What seems at present the most likely course is

is northeastward across NW part of sec. 21 and through secs. 16, 15, 10, 13 & 2 & 1, Henrietta Twp. and secs. 31, 32, & 33, 29, 28, 27 to Stockbridge and then into the strong moraine in western Unadilla Twp., Livingston Co. There is a string of swamps and swales S. of the line from Stockbridge SW to sec. 32, Henrietta Twp. The hummocks are not numerous along this suggested ice border yet there is scarcely a sec. without some hummocky land and most of the surface is undulating.

Within a short distance S. of this line morainic features set in but these seem to find continuation westward on the S. side of the Henrietta outwash plain, the prominent hills near White Lake being in it. An esker in secs. 22 & 27, Henrietta, is in this moraine. The trend of this esker is southeasterly and at that time the ice border may have been along or near the Portage River below Portage Lake.

Some further work may clear up the position of ice border in this district where the morainic features are so scattered. There are bouldery strips which may help to fill in spaces between morainic knolls. It is probable ponded waters were held in the Grand River and its tributaries from the time the ice border shrank away from the prominent outer moraine of the Kalamazoo system - until a passage was opened westward from Raisin Rapids. There was of course earlier drainage at higher levels than 950' to the Rice Creek & Kalamazoo drainage on the courses traced in the Springport quadrangle but Grand River and tributaries had more or less ponding at the time these lines of discharge were operating. After circuiting Pleasant Lake I went from Henrietta village direct to Jackson and took electric car to Ann Arbor.

Studies in River Jc. Quadrangle

Sept. 26. I returned to Jackson and went N. on Main Street about 3/4 mile beyond city limits in bouldery moraine. The Round Top School is on this moraine and it extends a little into sec. 31, Leoni Twp. in SW $\frac{1}{4}$.

It also embraces the ridges in the N. part of sec. 31. The outwash of sandy gravel sets in S. of a swamp that runs ENE across the N $\frac{1}{2}$ sec. 31.

It covers S. part of secs. 32, 33 & 34, but the N. part of these secs. is either morainic knolls or swamp.

In sec. 30 there is sharp morainic topography on the N. part but the remainder is nearly plane sandy gravel with few, if any, boulders. It is perhaps to be classed as outwash. After crossing a sharp range of knolls in NW part of sec. 30 I come to another nearly plane area of sandy gravel in S. part of sec. 20. The remainder of sec. 20 is strongly morainic.

There is strong moraine in sec. 16 ~~th~~ough some swamp occurs in NW quarter. Sec. 10 also is nearly all morainic but has a little flat sandy land in SW part. In sec. 9 there is a loamy soil with a few boulders in dry land in E. part but the W $\frac{1}{2}$ is sandy where above the marsh level.

The marsh along Portage River in secs. 3 & 4 is dry enough to run mowing machines over it and much wild grass is cut. The dry land NW of Eagle Lake in sec. 3 is sandy with but little loam, but that in the E. part of sec. 3 is said to be a heavier soil apparently till.

The land on the prison farms in secs. 8 & 9 is light soil where it stands above the marsh. In the E. part the wet land has cat tail flags and is boggy. This is mainly in sec. 9. The wet land in sec. 8 is less boggy and much of it can be made agricultural land as noted when there in August. I crossed Portage River in sec. 3. The dredge has thrown out sand below the peaty muck in its course across sec. 3. There is reported to be sandstone in the stream bed a short distance W. from this bridge.

There is strong moraine with numerous boulders NW from this bridge as far as Root Station. There is a strip of nearly plane land with loamy soil and a few boulders running along the Grand Trunk RR in SE part of sec. 33 but in the central part of the sec. there is strong

moraine. This runs SW across SE part of sec. 32, Henrietta, into sec. 6, Leoni Twp. There is also strong moraines S. and W. of White Lake in secs. 29, 30, 31 & 32, Henrietta. I went W. from Root Station on town line and then N. to White Lake and W. across sec. 30 through the moraine just noted. It is thickly strewn with boulders. The drift in places is a clayey till but generally is very loose textured stony material with a stony loam soil.

Features in Rives Jc. Quadrangle

I cross a strip of muck land in a valley in sec. 25, Rives Twp. whose NE end is at the border of the outwash plain of sandy gravel noted Sept. 24. Below the muck is a sandy deposit with a few pebbles and a few boulders. To the W. of this valley is knolly land with numerous boulders clear to Grand River valley in sec. 26, Rives Twp. It is less prominent than the moraine to the E. but is likely to be its continuation. To the S. of this in secs. 35 & 36 most of the surface is nearly plane. It is a till tract to be classed as ground moraine.

In Grand River valley in secs. 26 & 35 a pebbly loam occurs in places and in places a clayey till with a few boulders. There is an abrupt rise of about 20' at the E. bluff from 920' or less to 940' contour. The drift is looser textured than in most of the bottom land.

Inasmuch as this part of Grand River valley seems to have been occupied by ponded water for a considerable period after the gravel filling was laid down in it in northern Rives Twp. up to a level of 930' or more, it is not easy to explain the appearance of erosion presented by the abrupt bluff in secs. 26 & 35. Perhaps there was an advance of the ice border to the N. edge of this outwash and a filling in a valley that had been open before so that Grand River could cut down to about 910'.

The mucky valley that I crossed in sec. 25, Rives, seems to have been filled by outwash at the N. as if there had been readvance. It may have been cut by a north-flowing stream. The present drainage breaks through to Grand River in a narrow gap S. of Zion Church on line of secs. 25 & 26.

A low tract crossed on line of secs. 1 & 2, Blackman Twp. has a black pebbly loam soil with little or no muck. The upland S. of this near corners of secs. 1, 2, 11 & 12, have limestone so near the surface it is exposed in road ditches 2' deep. SW of this is the clay pit in NW $\frac{1}{4}$ sec. 11 that has shale and clay and a little sandstone as noted in previous trip. I returned from here to Jackson and Ann Arbor.

On Grand Trunk Durand to Flint

Sept. 27, 1921. Ann Arbor to Durand on T & AARR and Durand to Flint on Grand Trunk RR. There is a gravelly knoll N. of G.T.RR in SE part of sec. 15 that catches 790' contour. A low ridge of gravel runs eastward in SW part of sec. 7, Gaines Twp., that causes the protrusion of 780' contour.

The low ridge S. of Grape Farm in secs. 9 & 10 that catches 790' contour has been opened for gravel at its W. end and the cultivated fields on it have appearance of a gravelly ridge. It is separated by a narrow channel from the till plain to the south, the bed of the channel being about 780'. Near center of sec. 2 are gravelly deposits in midst of the Inlay outlet on S. side of G.T.RR which reach 780' contour only in highest points. There is a slightly wavy gravelly surface from here E. to Swartz Creek station on S. side of the track.

Studies near Flint

From Flint I went out Saginaw Ave., to Atherton road and then E. to corner secs. 20, 21, 28 & 29, Burton Twp., then N. 1/2 mile and W. to center of sec. 20 then southward to sec. line of 20 & 29. By this

circuit I determined that the sandy gravel in sec. 20 is nearly all in the SE $\frac{1}{4}$ except that at head of Thread Lake in SW corner. It is as far down as 770' contour on the NE edge but most of it stands above 780' contour. The SW part of sec. 21 has a loose textured sandy loam and in places sandy soil. There are a few boulders in this loose textured material along the line of secs. 20 & 29, 21 & 28.

There is a small gravel pit in the bottom land of Thread River at S. side SE $\frac{1}{4}$ sec. 21. It shows thin beds of medium sized gravel alternating with sandier beds. The pit reaches ground water level at 4'. This stream had a valley flat 40 - 60 rods wide in its course through secs. 28 & 21.

On the E. bluff near N. end of line of secs. 27 & 28 there is a small knoll 790'+ with a thin coating of sandy & pebbly material over till. A bar of sandy pebbly material extends E. & W. from this knoll to the line of secs. 22 & 27 about 40 rods E. of the sec. corners. This is slightly below 790' probably 787 - 788'. It may be the work of the Glacial Kearsley Lake for it is probable the lake was above 780' here. Differential uplift may make it a little higher here than the head of the outlet near Otterburn???

I found no sandy gravel, nor any definite shore features along or near the line of secs. 22 & 27, 23 & 26, 24 & 25, to the E. of the bar just noted, though the 790' contour is close by. A high spot in a field in NW part of sec. 25 is probably 795' and is a little looser textured material than that of the surrounding plain. Nearly all the roadside exposures are of clayey till with pebbles in moderate number. There is another high spot E. of center of sec. 24 that is about 795'. This also has a looser soil than the plain around it. I passed a flowing well in SW corner of sec. 24 at alt. about 780'. It runs a very weak stream at about 1' above the ground in a swale.

I found basins more conspicuous in SE part of sec. 24 and NW of sec. 25 than anywhere N. of Thread Lake and the basin tract around its head. I went N. on line of Burton & Davison Twp. to the Flint-Japeer highway. I am in a smooth plain descending northward till I cross a small tributary of Kearsley Creek near N. end of line of secs. 19 & 24. N. of this is a gently undulating strip standing above 730'. It is of till but has scarcely any surface boulders showing in fields or dooryards. It seems uncertain whether it marks the position of a brief halt of the ice border. Its undulations are slight scarcely 5' from sag to swell. A prominent point N. of center of sec. 24 catches 790'. I turn W. on the Flint-Japeer highway which runs on the 1/4 line of secs. 13, 14, 15, etc., of Burton Twp. There are some ridges and knolls of loose textured drift in NW 1/4 sec. 13 that are fully 10' above border plain. They have a few boulders near this highway. It is uncertain whether these were formed mainly by glacial action or instead by Lake Kearsley. The prominence is somewhat greater than I expected to see in shore features of Lake Kearsley. From sec. 13 westward into the City of Flint there is clayey till exposed at many points by ditches at roadside. The surface is not so flat as in some of the district to the S. that I went through when going eastward.

In Flint I examined cuts at side of S. Saginaw Ave. for 1/2 mile SE of the Courthouse and find a pebbly clay with only small & thin patches of sand or sandy loam.

Studies Near Flint

Sept. 28, Flint, Mich. I take electric car SE to Howe??? Station on line of secs. 26 & 27, Barton Twp. There is a clay loam soil here at 790' alt. I go S. 1/2 mile to Howe School in clay loam soil with till subsoil. Am told the land becomes looser textured near Burton Church with much pebbly material and continues so to Grand Blanc.

I go W. on line of secs. 27 & 34 and come into loose textured soil in 1/4 mile that continues past Thread River valley. The surface is nearly plane N. of Thread River but is knolly W. in SW part of sec. 28 and NW of sec. 33. The knolls seem to be gravelly drift. There is a flat clayey till around corners of secs. 28, 29, 32 & 33. The NE $\frac{1}{4}$ of sec. 32 is very flat till. In sec. 29 there is considerable sandy gravel in vicinity of Pere Marquette RR mostly above 790' contour. A sandy ridge takes the 790' contour in NW part of sec. 32. There is clayey till each side of it.

There is a little gently undulating till in S. part of sec. ~~31~~ 31 and it has a swale along a small stream but most of the sec. is till plain. In sec. 36, Flint Twp., there is a little wavy surface in central part of NE $\frac{1}{4}$ due to slight deposits of fine sand on the till. These deposits are above the 700' contour and may be due to glacial Lake Kearsley. The ridge in S. part of sec. 36, Flint Twp., that rises above 700' contour is not sandy. It has a few boulders and smaller stones on its surface.

In NW part of sec. 1, Mundy Twp., is a low swell on which a pile of boulders appears. It catches 800' contour. The moraine sets in in sec. 12 and S. part of sec. 11, Mundy Twp. It runs just across secs. 7, 8, 9, Grand Blanc Twp. I see no indications of a shoreline of Glacial Lake Kearsley as I go W. on the line of Flint and Mundy Twp. (secs. 35 & 34, Flint; secs. 2 & 3, Mundy Twp.). There is yellow till with an occasional boulder. The surface is remarkably flat in secs. 2 & 3 but becomes undulating in secs. 10 & 11, Mundy Twp. On crossing Swartz Creek on line of sec. 35, Flint and sec. 4, Mundy twps., I come into sandy & gravelly land. There is a knolly bouldery drift that catches the 700' and 750' contours and has a morenic aspect. The surrounding country is flat. I come into a till plain, clayey till, near corner of

secs. 32 & 33, Flint, and secs. 4 & 5, Mundy. This is about 780' for 3 miles N. on W. to N. line. I can see nothing to indicate the limits of Glacial Lake Kearsley though it was close to this level where it opened into the outlet in secs. 29 & 30, Flint Twp.

I went N. on line of secs. 32 & 33 near the head of the outlet and took the angling road NE to Flint on the Flint moraine. This is a till moraine with rather clayey texture and only a few boulders. Its relief is such, however, above bordering plains as to make it very conspicuous. The surface is a gentle swell and sag type. I passed the head of the small channel that runs across the moraine from Swartz Creek through secs. 28 & 31, Flint. It is only 40-60 rods wide and has a sandy gravel bed here and also where the Grand Trunk RR crosses it in sec. 31.

Studies near Flint

I took a road leading NE along E. bluff of Flint R until I crossed ^{Silkney?} Galkoy Creek. This is through a sandy gravel strip that forms a narrow fringe on this side the river valley as high up as the 750' contour. I turned east on the "Davison Road" and found that only the eastern part of sec. 5 about 1/4 of the section - has till at surface. The remainder has a coating of sandy and pebbly material. This also covers the NW corner of sec. 8 about 80 acres but the rest has till at surface.

At corner of secs. 4, 5, 8 & 9, a trench for water connection is 6' deep and the lower 3' is loose yellow sand. Above this is a mixed sand and clay with a few small stones. It is not typical till but there is typical yellow till full of small stones and strewn with boulders in much of secs. 4 & 9 and eastward in secs. 3 & 10. The surface is very flat as far as Kearsley Creek. I went N. into sec. 33, Genesee Twp., and then E. across Kearsley Creek and then along Richfield Road to NE corner of sec. 36. There is undulating clayey till in the NE part of

this sec. mainly above 730' contour. It seems to have had no wave action to smooth the surface above 730' or perhaps 775'. I can see undulating till in sec. 30, Richfield, with boulders so numerous there are piles in the fields. This is above 730' contour. There is similar undulating till to the SE in sec. 31 above 730' contour.

I returned on Richfield Road to sec. 34 and continued W. to line of secs. 33 & 34. I there went N. and crossed Kearsley Creek at its bend. There is a little sandy material S. of the creek below the 760' contour. The creek cuts into a bluish clay a few feet. It looks to be but slightly pebbly. There is till near top of bluff with a few boulders and coarse stones. This has a thin coating of pebbly sand, scarcely enough to conceal all the boulders. I went W. on line of secs. 28 & 33 and found the soil sandy but I saw several large boulders.

I went S. through W. part of sec. 33 across Kearsley Creek. There is sandy & pebbly material with an occasional boulder on the S. as well as N. bluff. There is a low ridge running SW across the SE part of sec. 32 that barely catches 760' contour in its highest points. This is of pebbly sand and in the sand are a few boulders both large and small. It is about the size of a lake beach and may represent a low level of Lake Kearsley after drainage was shifted to pass through the Flint moraine.

I go S. through center of sec. 5 and am in sandy & pebbly material to S. side of the sec. at the Davison Road. I crossed Gilkey Creek on a boulevard just N. of the GTRR and found the E. bluff here is yellow till. There seems to be sandy material nearly to where the blvd. turns SW across the valley. There is also a sandy material on W. bluff about to GTRR.

Sept. 29, 1921. Flint to Davison on GTRR. I went W. from Davison $2\frac{1}{2}$ miles to the ridges in secs. 6 & 7. There is but little sand

here. They are till ridges the till being mainly clayey but sandy in places. The western string of knolls has very fine sand exposed like Welder's sand where road crosses. They are at the level where the shore of Kearsley glacial lake should be about 780' A.T. Walker brothers in W. part sec. 5 have well 215' deep that is 70' into rock. Head - 15'. Alt. 785' or more. Water is soft. There was mainly clay - some blue color but some gravel beds. Mrs. Davison has well 200' deep that flows a strong stream. It is in E. part sec. 1, Barton; Alt. 760'. Rock is generally struck in this vicinity at 150' or less.

I went N. to corner secs. 19, 20, 29 & 30, across till plain rather clayey and with a moderate number of boulders. The surface is gently undulating above 770' contour. There is a knolly sharply ridged strip of land of morainic type running ESE from SW part of sec. 30 across N₂ of sec. 29. Its highest points catch 820' contour. The morainic topography is mainly above 800' contour. There seems to be a continuation of this morainic strip in S. part of sec. 18, Richfield, but here it is gently undulating much like the till plain. Its highest points catch 790' contour. It is undulating down to 780' contour but relatively smooth below. In SW part of sec. 18 is a nearly plane tract between 760' and 770' that marks the bed of the Glacial drainage at Head of Lake Kearsley. A definite channel leads SW across sec. 19, 24 & 25, into the lake. It is sandy up to or a little above 760' contour. There is some effect of current action up to about 770' on line of secs. 19 & 24. It is terraced at about this height. Above 770' there is a rising slope and I see nothing to indicate stream work.

I crossed Genesee River on line of secs. 17 & 18 and pass the large gravel pits on N. side the River. The main pit is in S. part of sec. 7 where a railway switch from the Pere Marquette comes into it. There are small in NE part of sec. 18 and NW of sec. 17. The gravel is

mostly clean grey gravel of medium to coarse grade - many pebbles 1-2" in diameter. The surface of this gravel is about 750'. There is a slight capping of sandy loam 1-2'g.

On line of secs. 7 & 8 there has been stream action up to the 750' contour. On line of secs. 6 & 7 it extends a little above 750' contour to the house on S. side of road near the quarter post. The soil is sandy and surface flat that far N. The sandy soil & flat surface extends to Rogersville at 750' or slightly higher. There is gravel opened for road use on Butternut Creek SW of Rogersville in S. part of sec. 1, Genesee Twp.

My former sketches show that sandy land only covers S. part of sec. 1. The N¹ is clay down to 750' or less. In W. part of sec. 2 and on line of secs. 2 & 11 there are moraine knolls that seem to be a continuation of the "slender" moraine noted this morning S. of Flint River in secs. 18, 20, & 29, Richfield. The ice border fronted NE in western Richfield and northeastern Genesee Twp. The river cuts through this moraine in sec. 11. The area above 750' in W. part of line of secs. 13 & 14 probably pertains to this moraine though it is very nearly plane. Boulders are very numerous in central and NE part of sec. 14 with large piles in fields and along fence lines. These probably pertain to this ice border. Where this weak moraine crosses the river has cut to a level 40-70' below its highest knolls near the stream the water level opposite Genesee village being 709'.

There is a sandy bar along the brow of the S. bluff of Flint River opposite Genesee village that stands a little above 750' at the houses near middle of line of secs. 14 & 15. It is 50' above land immediately south. The bar is 50 x 100. There are a few coarse stones in it but it is mainly sand with a few pebbles. There are places down the valley into Flint where as noted yesterday a bay is developed

along this bluff of Flint River at about 760'.

From Genesee village I went S. and crossed a till plain for a mile S. of the river bluff or to middle of line of secs. 22 & 23. There are a few surface boulders and the soil is a loose textured pebbly loam. I then cross the abandoned channel of Flint River that I noted this morning in secs. 19, 24, 25. It is very shallow and vague here. There are, however, sandy strips or bars. A conspicuous one being in SW $\frac{1}{4}$ sec. 22 that catches 760' contour. There was probably ponded water here about to 760' and in the district SW into Flint. I returned to Flint through sec. 5, Burton, and westward on Davison Road.

On Electric RR Flint to Detroit

I took electric car Flint to Detroit at 2:20 P.M. There is till plain of clayey loam as far as SE part of sec. 36, Burton Twp. A moraine about a mile wide is then crossed.

A glacial drainage channel is crossed near N. end of line of secs. 7 & 8, Atlas, about 1/2 mile outside the moraine. This was traced from sec. 33, Davison Twp. SW to Grand Blanc in my earlier studies. It varies in width from 1/3 mile to over 1/4 mile and much of it is now swampy.

SE from here past Atlas and Goodrich there is till plain with a remarkable amount of depressions but with scarcely any knolls. It is largely a clayey till. There is very little strong moraine until I pass Ortonville. (See notes on earlier studies from Ortonville to Detroit).